TRACK TECHNIQUE

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How They Train

by Fred Wilt

BRUCE KIDD, East York Track Club and Malvern High School, Toronto, Canada, age 17.

BEST MARKS: 10,000 m, 31:53.0; 6 miles, 30:48; 5000 m, 14:29.9; 3 miles, 13:53.6; 2 miles, 8:49.2; 1½ miles, 6:42.0; mile, 4:10.6; 1500 m, 3:53.4; 3/4 mile, 3:03.0; 1000 yards, 2:18.2; 880 yards, 1:55.3; 660 yards, 1:24.5; 440 yards, 52.2; 220 yards, 25.0 seconds.

BORN July 26, 1943 at Ottawa, Canada, 5' 8" (173 cm.), 132 lbs. (60 kg.), started racing in 1958 at age 14 years.

PRE-RACE WARMUP: Begin 45 minutes prior to race-time. Jog slowly until quite warm. Then a "few minutes" of walking, followed by more slow jogging. He acknowledges no standardized or rigid pre-race warmup. No calisthenics are included.

PRE-TRAINING WARMUP: During Autumn when training for cross-country racing, each workout begins with a 3½ miles run through the streets as a warmup. At all other times during training the warmup is merely 20 minutes of easy jogging.

FALL TRAINING: (September through October, 1960). Venue - cinder track. Monday: 8 x 880 yards in 2:20-2:23, jog 440 yards after each. Tuesday: 6 x 3/4 mile in 3:35-3:40, jog 440 after each. Wednesday: 20 x 330 yards in 46-48, jog 110 yards after each. Thursday: 20 x 440 yards in 68-71, jog 440 after each. Friday: Rest or repeat Wednesday's training. Saturday: Race or repeated intervals in hills, followed by 6½-8 miles run through hills. Sunday: Rest.

WINTER TRAINING: (December, 1960 to March, 1961). Venue - Hart House, University of Toronto, cork-rubber composition surfaced, 153 yards per lap, indoor track with banked turns. Monday: 8 x 765 yards. Tuesday: 8 x 918 yards. Wednesday: 8 x 765 yards. Thursday: 20 x 459 yards. Each of these repetitions is run at a speed of 68 seconds per 440 yards, and each repetition is followed by 320 yards of rapid recovery jogging. Friday: 20 x 320 yards at 67 per 440 speed, jog 160 yards after each. Saturday: Race or time trial. Sunday: Rest.

SUMMER TRAINING: (May and June only. After June, the training volume and intensity is reduced due to hot weather). Venue - 440 yards cinder track.

Track Technique

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Monday: 8 x 3/4 mile in 3:24-3:28, jog 440 yards after each. Tuesday: 6 x 1 mile in 4:40-4:42, jog 880 after each. Wednesday: 10 x 880 yards in 2:16-2:21, jog 440 yards after each. Thursday: 12 x 660 yards in 1:33-1:35, jog 220 after each. Friday: Rest, or 30 x 220 yards in 31-33, jog 110 yards after each. Saturday: Race or time trial.

Kidd trains the year round, and acknowledges no "off-season" or rest period from training. He never trains more than once daily. The duration of each workout is two hours, usually from 5:00 PM to 7:00 PM daily. He participates in six indoor races, six cross-country races, and twelve outdoor track races annually. He rests one day prior to competition, and last eats four hours before racing. He is coached by Fred Foot, a Toronto Police Force accountant, in conjunction with Bill Eckersley, a Toronto High School teacher and coach. He does not use weight training and does 15 sit-ups each morning.

His "time trials" are pacing runs, rather than interclub competition, the objective being to maintain a uniform pace over a given distance. These runs from December, 1960 to March, 1961 have been from 18 to 35 laps on the Hart House 153 yards indoor track, at a constant speed of 24 seconds per lap. He recently ran a paced 35 laps (5355 yards or 3 miles and 75 yards) in the equivalent of 13:45 for three miles. His ambition is to break 13 minutes for three miles. Recently he doubled in one meeting, returning 4:12 for the mile, and 8:58 for two miles. Normally, however, he does not race twice the same day. He prefers competition at full effort once each ten days.

In Toronto, High School athletes are free to compete for clubs of their choice except during the month of May - in contrast to restrictions in most states of the USA, prohibiting club competition by High School athletes.

The following graph of best marks by age reveals the fantastic potential of this youthful champion:

Event	Age 14 (1958)	Age 15 (1959)	Age 16 (1960)
440 yards	62.0	53.7	52.3
880 yards	2:10.6	1:58.0	1:56.1
Mile	4:51	4:23.6	4:10.6
Two-miles		9:25.0	9:27.9
Three-miles		14:26.0	14:07.6 (9:22.4 at-two-miles-mark!)

In explaining the philosophy, method, and technique employed in training at the East York Track Club, Kidd writes: "Our work is planned by our coach, Fred Foot, and our method of training is guided by two basic principles: (a) an athlete runs with his legs, and (b) the speed of muscular contraction is innate or inborn. We regard the legs as being all important. For maximum results they should be used as efficiently as possible. This is achieved when the athlete concentrates on maintaining a leg action which is both economical and brisk. The arms are forgotten and considered as functioning as instruments of balance, operating in response to the leg action. This first principle then governs our form, the second governs our training.

"Since speed is inborn or innate, we feel that it is next to useless to try to improve our performance through speedwork. Thus in the training time at our disposal we try to build stamina. Under this method sprint times improve because the athlete builds the strength necessary to enable him to utilize his inborn speed over the racing distance.

"Our workouts vary from repetitions of 300 yards to one mile under the tyrannical domination of the stop-watch at all times. The total workout, including the recovery jogging, usually covers from 5 to 10 miles. We rest one day each week. In our training, the emphasis is placed on the distance covered rather than on the time the athlete covers the distance. For example, should a workout (such as 20 x 440 in 68 seconds with a 150 yards jog for recovery after each) be cut in half for those athletes for whom it is too strenuous, or should the weaker athletes complete the full workout, but at a much slower speed? We feel it is better for the weaker athlete to complete the full workout, but at a much slower speed, such as 75 seconds per 440.

"I wish to emphasize that not only our middle distance runners follow this schedule! Everyone does it. The sprinters and newcomers follow perhaps a modified version, but this is only until they build their stamina to the point where they can join in the fun! "

Weight Training for Young Track & Field Athletes

by John T. Powell, University of Illinois

It has been proved that the wise use of weights not only increases an athlete's strength and mobility, but also aids speed of reaction. Weight training and weight lifting are different, although each can be used advantageously at different stages of an athlete's career.

Weight training alone will never produce a champion athlete; but it will aid in the production of one. Weight training is not a substitute for hard, conscientious and sound practice on the track, over the country and in the field, but it is a valuable tool to be used by a wise coach and an intelligent athlete.

Weights should be used all year round. There is no need to stop training with weights during the competitive season, although naturally the time then available for this type of work will be reduced. It is suggested that weight training sessions should be 3 times each week (on alternate days) out of season, and once each week in season. Remember, there is no reason why weight training should not be conducted out of doors when weather permits.

METHOD Speed depends upon strength. The stronger the athlete the more fully and faster he can react. Endurance, also, is built on strength, but this does not mean that great totals of weights need be lifted to acquire strength. Further, it is not necessary to experience the effort of lifting the weight every time.

Work should be rhythmically done--not slow, not fast but brisk. Whole movements should be made--not partial ones. The muscles used should be worked throughout a full range.

For track and field athletes the sets and repetitions method is best. As a guide, the number of sets and the number of repetitions which will give an adequate work-out are indicated. However, the coach should change any (or all) of these as observation of the individual athlete indicates. No exact amount of weight, fixed number of repetitions or total time for practice can be set down; these depend upon facilities, ability, experience, supervision, time available and equipment used. The suggested number of repetitions and sets are found in a bracket at the end of each exercise:- (8 reps. 3 sets). This means that eight consecutive performances of the exercise are made, the weights are put down, there is a short rest, then a further eight movements are done- rest- followed by the third set of eight movements. The pause between sets should never exceed 30 seconds.

PROGRESSION As improvements are made, so progression and interest need to be sustained. Here are some ways to encourage continuity.

1) Keep same weight, but reduce the time of rest between sets.
2) Keep same weight, but increase the number of repetitions (maximum 25)
3) Keep same weight, but increase the number of sets (maximum 5)
4) Keep same weight, but increase the number of sets and number of repetitions.
5) Increase the weight, maintain the same number of sets and repetitions.
6) Increase the weight then change as in 1, 2, 3, 4, above.
7) Repeat the whole series.
8) Gradually substitute new (and appropriate) exercises.
9) Completely change the exercises performed.

However, it may be simpler just to add weight to the dumbbells, iron boots or bar, after repititions and sets have been performed with ease. But, if weight is added, the number of repetitions should be reduced in each set. Progress is then made in repetitions until the original number has again been reached. This method is especially useful when an athlete works on his own without supervision.

Generally a guiding principle in progression is :-Speed and strength require low repetitions but increasing weight. Endurance is obtained by many repetitions with relatively unchanged weight.

WARM-UP Before every session with weights a warm-up should be performed. This should be carefully and conscientiously done. It should last fully 15 minutes, performed either with weight equipment or by full-range (not static) calisthenics, and should always include running. Thereafter, about 30 minutes should be spent weight training.

SAFETY FACTORS 1) Always warm-up thoroughly. 2) Never interfere with anyone when he is working. 3) Only the work set should be attempted. 4) When using a barbell across the shoulders protect the neck by means of a towel. 5) Check that correct poundages are being used. 6) Check that "collars" are firmly clamped to bars. 7) Check that straps are properly buckled. 8) Put weights away when work-out is finished. 9) Always wear a sweat suit, and if necessary a heavy sweater as

well. Keep really warm. Remember, a suitable weight training program must involve personal effort to the point of sweating, and great respiratory action as a result of the hard muscular activity. Therefore, if working indoors see that there is an adequate supply of fresh air. If the training does not create a good sweat, personal effort has not been enough, poundages are too light or repetitions too few.

TRAINING DIARY One of the most satisfying experiences is to keep a weight training diary. This record should be completed directly after each work-out, giving total repetitions and sets, exercises used and such personal things as how one feels, whether it feels better to work with others around or on one's own, whether training outdoors is preferable to indoors and so on. When an athlete is feeling down he should refer to his diary, he will hardly credit the amount of improvement made and will be encouraged to continue with even more determination.

SUGGESTED WARM-UP USING BAR WITHOUT WEIGHTS.

1) (Stand astride--feet flat--toes to front, palms of hands towards body) Grasp bar resting on thighs--bend arms, elbows raised sideways, until the bar comes in line with jaw, then lower arms until bar is at starting position. (20 reps.)

2) (Stand astride--feet flat--toes to front) Place bar behind neck, grasp bar, stretch arms above head. Alternately bend and stretch arms, pushing bar as high as possible. Keep head still, look to front. (20 reps.)

3) (Standing feet together) Raise arms forward, grasp bar in line with shoulders and keep bar at arms length while running on the spot. Count aloud for 100 running paces.

4) (Standing feet about 18 inches apart--bar behind neck). With heels down deep knee bends--vigorous but not fast, keeping back flat. Trunk should not tip forward. (10 reps)

5) (Standing astride, feet flat throughout, toes to front, bar behind neck) Grasp bar firmly, Trunk bending from side to side. This movement cannot, if done correctly, be performed very far to each side--hips should be still, no twisting at the hips should be experienced. (20 reps.)

6) (Standing astride--feet flat, toes to front, bar grasped across thighs) Trunk dropping down and stretching up allowing bar to touch ground in front of toes. Legs should be straight throughout exercise and back should be rounded when going down and when raising. (20 reps.)

7) (Back lying, bar grasped on thighs) Sit up, pushing bar along legs until it is placed over toes and under the arches of the feet. Pull on bar (legs straight throughout) and press head to knees--return to back lying, bar on thighs. Round back at all times. (10 reps.)

8) (Front lying, bar held with arms straight below "seat", head resting to one side). Take deep breath, raise bar and lift chest off ground, turn head, lower chest and exhale--perform powerfully. (20 reps)

9) (Standing, feet together, bar held across thighs, arms straight) Astride jumping with arms raising forward--count aloud for 100 counts. As legs jump astride the arms are raised forwards in line with the shoulders, as the feet come together the arms are lowered, the bar touching the thighs. A regular rhythm should be insisted upon.

As a general rule breathe deeply on all raising movements and exhale powerfully on all lowering ones. Stiffness is to be expected as the results of the first two work-outs. However, once started, weight training should be continued. There should be no fear of becoming "muscle bound" as this condition does not exist, and if the basic positions (given in brackets) are observed there will be no danger of "straining" a young athlete.

WEIGHT TRAINING FOR SCHOOLBOY SPRINTERS

1) Alternate Press. (Standing astride, feet flat, toes to front--holding a 10 lbs. dumbbell in each hand at the shoulders) Alternately fully stretch upwards one arm then the other, drive one arm up as the other comes down. Keep each weight above the shoulder. (8 reps. 3 sets)

2) Sprint Arm Action. (Standing one foot and body slightly forward, knees fractionally bent---holding a 5 lbs. dumbbell in each hand) Work arms as in sprinting. Never straighten arms, each bell should move between shoulder and hip. Foot position should be changed for each set (12 reps.3 sets)

3) Pull-over, knees bent. (Back lying, knees bent, feet flat on floor--arms stretched behind head grasping barbell (15 lbs.) Swing arms straight until bar touches thighs, then swing arms back again to starting position. (8 reps. 3 sets)

4) The squat. (Standing astride, feet flat on floor--grasping barbell (15 lbs.) behind neck) Keeping whole of weight over feet (no heel raising) knees full bending and stretching. Allow body to lean forwards but back should be straight. (12 reps. 3 sets)

5) Knee curl. (Back lying, hands flat on ground about 6 inches from sides of body--5 lbs. iron boot on each foot) Raise legs together, fractionally, from the ground then snap knees to chest (keeping seat on floor) straighten legs and lower quietly to ground. This is not a slow exercise. (6 reps. 3 sets)

6) Balance shoot. (Sitting, hands flat on ground in line with hips--5 lbs. iron boot on each foot) Raise legs together then pull knees to chest, straighten legs and repeat. Legs do not lower to ground until each set is completed. (6 reps. 3 sets)

7) Trunk lean. (Standing feet astride, toes to front--grasping barbell (15 lbs.) behind neck) Trunk leaning forward (only parallel to ground) eyes directed to the ground, and stretching up again. Back and legs should be straight throughout performance of the whole exercise. (12 reps. 3 sets)

8) The spring. (Standing, feet together--grasping barbell (15 lbs.) behind neck) Bounce up and down from both feet (skip jumps) and on every 4th bounce extend ankles and thighs violently stretching the body fully. There should be no pause, continuity is important. (12 reps. 3 sets)

Note:- Perform exercises in the order set. Before attempting the above series warm-up thoroughly. Breathe deeply on all raising movements---exhale powerfully on all lowering ones.

WEIGHT TRAINING FOR SCHOOLBOY HIGH HURDLERS

1) Knee bobbing. (Standing--10 lbs. barbell grasped behind neck) Jump to lunge position with front knee bent above foot, rear leg stretched and straight, body erect. Alternate bending and stretching rear leg until the knee thouches the ground on each bend. Then, change position by a jump, until the other foot is forward and the rear knee is bent and stretched. Chest should be kept high and head up, eyes directed at a spot in the distance. (8 reps. 3 sets each leg)

2) Breast stroke. (Sitting, feet astride--5 lbs. dumbbell in each hand) Raise arms forward--in line with shoulders. Pull arms sideways and quickly draw dumbbells under armpits then shoot arms forward again. This should be a continuous movement. (4 reps. 3 sets)

3) Hurdle sit. (1). (Sitting, one leg forward straight, other leg bent at an angle sideways, knee bent as when over a high hurdle--holding the bar outside the discs of one 10 lbs. dumbbell with both hands.) Stretch arms forward until the bell is over the ankle (toes should be pulled towards face.) Rhythmically press body down to thigh with the jaw further forward than the knee--10 times. Holding dumbbell in line with chest change position of the legs and repeat exercise. Rest only after each set. (10 presses. 3 sets each leg)

4) Hurdle sit. (2). (Sit as in exercise three above, left leg forward) Take 5 lbs. dumbbell in right hand, place left hand on left knee. Keeping dumbbell up place right elbow on ground in front of body. Pressing body forward circle right elbow around right knee--keeping elbow on ground. Make the circles continuous. Change weights to other hand and reverse position of the legs. (4 reps. 3 sets each leg)

5) Leg side raise. (Standing one foot on a box or a solid bench 8 to 10 inches high--5 lbs. iron boot on other leg.) Swing weighted leg sideways and return it to starting position. Grasp a support with the hand on the side of the supporting leg. The swinging leg should not be raised high, body should be erect and the hips still. Change after 6 side raises. (6 reps. 3 sets each leg)

6) Foot flick. (Sitting, hands further back than hips--5 lbs. iron boot on each foot) Raise legs until body and legs resemble a V sit position. Keeping thighs and knees high drop legs (from knee down) until boots hit seat, then on the rebound stretch legs again. (6 reps. 3 sets)

7) Step up, step down. (Standing, facing solid box or bench 8 to 10 inches high--10 lbs. barbell grasped behind neck) Step up and down on bench counting out aloud for 50 complete steps. Rest half of one minute then continue for the other 2 sets. (50 steps. 3 sets)

Note:- Hurdling is sprinting (with a few nuisances in the way) thus the young hurdler should perform the work set for the sprinters. In the Off-season this should be done once each week and the above schedule twice each week. In season work should use only the 7 exercises enumerated above. Thoroughly warm-up before any weight schedule and, when performing it, breathe deeply through nose and mouth.

WEIGHT TRAINING FOR SCHOOLBOY MIDDLE DISTANCE AND CROSS COUNTRY RUNNERS

1) Shoulder rolling. (Standing feet astride, toes to front--barbell (10 lbs.) resting on thighs) Lift shoulders as high as possible--keeping arms straight--and circle them backwards and down. Continue the movement ten times, then repeat, but circle shoulders forwards. (10 reps. 3 sets) (each way)

2) Abdominal curl. (Back lying, feet held down by wearing iron boots, or by a partner, holding a single 10 lbs. disc behind the head) Sit up with round back so that the head is pressed to the knees.

When returning to the starting position the back should remain rounded as long as possible. (8 reps. 3 sets)

3) Single knee raise. (Sit, hands further back than the hips, palms on ground-- 5 lbs. iron boot on each foot) Bring one knee up smartly to the chest, extend leg and lower it. Repeat with other leg. The knee should be drawn to the chest, not the chest to the knee. (8 reps. 3 sets each leg alternately)

4) Rowing. (Standing feet astride, trunk forward lean--5 lbs. dumbbell in each hand, arms hanging down) Keeping back flat, pull bells to touch shoulders, keeping elbows close to sides. Let the arms do the work in bending and stretching down again. (10 reps. 3 sets)

5) Step up--step down. (Standing, facing solid box or bench 8 to 10 inches high--10 lbs. barbell grasped behind neck) Step up and down on bench counting out aloud for 50 complete steps. Rest half of one minute then repeat, rest agin and repeat the whole exercise. (50 steps. 3 reps)

6) Double curl. (Standing, feet about 18 inches apart, toes to the front, with palms of hands away from body grasp 10 lbs. barbell) Curl bar until it touches the chest, return bar to starting position. Elbows should be always at the sides and the body held erect. Arms should be flexed and extended as fully as possible. (10 reps. 3 sets)

7) Seat kick. (Front lying, head to one side hands under face--5 lbs. iron boot on each foot) Flex both legs and allow heels to kick seat, then stretch legs fully to starting position. (20 reps. 3 sets)

8) Straight-arm pull-over. (Back lying, arms fully stretched behind head--grasping 10 lbs. barbell) With straight arms swing barbell to thighs and back again. Keep back flat on ground throughout. (10 reps. 3 sets)

Note:- Perform exercises in the order set. Before attempting the above series warm-up thoroughly. Breathe deeply on all raising movements--exhale powerfully on all lowering ones.

WEIGHT TRAINING FOR SCHOOLBOY HIGH JUMPERS

1) The splits. (Standing--grasping 15 lbs. barbell behind neck) Jump up and "split" the feet in a lunging movement. Land with front foot flat (knee above instep) toes to front and back leg straight. Jump again and change position of the feet. There is to be no pause between movements. Keep chest high, eyes directed to the front and back flat. (8 reps. 3 sets)

2) High pull up. (Standing, feet about 18 inches apart knees bent--grasping 15 lbs. barbell on ground) Vigorously straighten legs, raising on tip toes and pulling bar to jaw level. Lower bar by bending knees but bar should not touch ground. Repeat. This is a slick movement. (8 reps. 3 sets)

3) Upward swing. (Standing, feet slightly astride knees bent--grasping a 10 lbs. dumbell in one hand between feet--other hand on thigh) Swing the dumbbell forward and up on a straight arm coordinating this with a powerful stretching of the legs until the bell is above the head. Momentarily hold the position--returning bell to the ground and repeating without a break. (8 reps. 3 sets)

4) Alternate seat kick. (Prone lying, head on hands--5 lbs. boot on each foot) Alternately flex and extend one leg until heel hits seat. Allow legs to pass each other in the air--build a brisk rhythm. (12 reps. 3 sets each leg)

5) Legs circling. (Back lying, arms sideways palms down--5 lbs. iron boot on each foot) Raise both legs together to about 30 degrees and without pause open legs, allow feet to lower sideways then bring legs together again, raise them and continue to circle them. (4 reps. 3 sets)

6) Arms forward-sideways. (Standing feet astride, toes to front--grasping 5 lbs. dumbbell in each hand) Raise arms forward until bells are in line with shoulders, swing bells sideways in line with shoulders--then lower to sides. Repeat the movement without a pause. Body must not sway and arms should never raise above line of shoulders. (8 reps. 3 sets)

7) Squat jump. (Standing, feet almost together--firmly grasping 15 lbs. barbell across shoulders) Raise up on balls of feet, then drop to knees full bend position--immediately spring as high as possible fully extending thighs and ankles. As return is made to starting position allow ankles to "give". There is no pause. Keep bar on neck between sets and keep head up throughout exercise. (4 reps. 3 sets)

8) Step up--step down. (Standing, facing 8 to 10 inch box or bench--firmly holding 15 lbs. barbell behind neck) Step up and down on bench, counting out aloud for 25 full steps. It is imperative that the body be fully stretched at the top of each step. (25 steps. 3 sets)

Note:- Exercise should be performed in the order set but should be preceded by a thorough warm-up. It is recommended that free and full breathing should accompany every movement.

WEIGHT TRAINING FOR SCHOOLBOY BROAD JUMPERS

1) Broad jumpers should follow the schedule established for sprinters, but on alternate workouts should substitute the following exercises for exercises 3, 6, and 7.

3) Running on the spot. (Standing--firmly grasping with undergrasp, one 20 lbs. dumbbell, in line with waist, elbows bent) Running in place with high knee raising--keeping dumbbell close to body. (20 paces. 3 sets)

6) Heels up--heels down. (Standing, feet about 6 inches apart, balls of feet on a 2 inch high piece of wood--15 lbs. barbell grasped firmly across shoulders) Heels raising high and lowering to ground. Maintain a steady rhythm and keep knees straight. (12 reps. 3 sets)

7) Swing-it. (Standing, one foot on a box or solid bench 8 to 10 inches high--5 lbs. iron boot on other foot. Press hand (same side as weighted foot) against wall. Keeping body erect, and each leg straight, swing free leg forward-up and back. Gradually increase swing until iron boot is opposite waist. Allow no swaying at hips or bending of either leg. Repeat exercise with other leg. (20 swings 3 reps each leg)

WEIGHT TRAINING FOR SCHOOLBOY POLE VAULTERS

1) Press-ups. (Prone lying, toes on a bench or solid box 8 to 10 inches high, hands flat on floor, fingers to front and close to shoulders, elbows near sides) Have a 10 lbs. disc placed over the shoulder-blades and just touching neck. Alternately bend and stretch arms. At all times the eyes should be directed at the ground between the hands, the seat kept in line with the shoulders and the back kept flat. (6 reps. 3 sets)

2) Chest heaves. (Standing--5 lbs. boot on each foot) Grasp, at stretch height, either a suspended rope or a pole. Without springing or bending knees heave the body to hands, hold position, then quietly lower again. Refresh grip by pressing finger tips together after each set. (4 reps. 3 sets)

3) Dumbbell sit-up--legs swing. (Back lying--5 lbs. dumbbell in each hand--arms stretched behind head. 5 lbs. iron boot on each foot) Swing dumbbells, on straight arms, to touch ground at the side of the ankles, then swing bells back to starting position. Then raise legs together and swing them over so that the toes touch the ground between the held dumbbells--return legs to starting position. Do not start one aspect of this exercise until the other has finished. (6 reps. 3 sets)

4) Front-rock. (Prone lying--5 lbs. iron boot on each foot--head to one side, hands under face) Raise legs, toes clear of ground, lower toes and raise chest, elbows and head. Gradually rock on abdominals. (12 reps. 3 sets)

5) Arm curls. (Standing slightly astride--grasping 10 lbs. barbell with hands towards face, bar resting on thighs) Fully flex arms until bar touches chest, then fully stretch arms until bar touches thighs. No swaying at hips, or trunk movements forward and back should be tolerated. (12 reps. 3 sets)

6) Arms side raise. (Standing astride--5 lbs. dumbbell in each hand) Arms sideways raising and lowering. Arms should not come above shoulder height--check by observing whole movement in a mirror. Stretch tall throughout movement. (12 reps. 3 sets)

7) Rock and roll. (Sitting--5 lbs. iron boot on each foot) Bend knees, grasp ankles firmly and squeeze body to knees. Rock back and forth keeping body balled up, allowing knees to touch ground behind head (take care not to tip over backwards) on return movement rock so that ankles are as close to seat as possible. (20 reps. 3 sets)

8) Forearm twist. (Standing astride--5 lbs. dumbbell in each hand) Flex arms at the elbow (which stay pressed to sides) until forearms are parallel to ground. Rotate dumbbells inwards and out again with as full a twist as possible. (6 reps. 3 sets)

9) Heels up--heels down. (Standing, feet close together--10 lbs. barbell grasped behind neck) Heels raising high and lowering. Body should remain erect, eyes to front. (20 reps. 3 sets)

Note:- A thorough warm-up should always be indulged in before this workout. Remember, breathe deeply at all times.

WEIGHT TRAINING FOR SCHOOLBOY SHOT PUTTERS

1) The push. (Lie on an inclined bench at 45 degrees, feet flat on ground--barbell 20 lbs. grasped on chest in line with shoulders) Stretch arms and push the barbell at the angle at which the shot is to be released. Hold the position for a fraction of time, then return bar to chest. Perform powerfully. Dumbbells may be substituted for the bar; the exercise may also be done from the ground--knees bent. (6 reps. 3 sets)

2) The hop. (Standing on one leg--10 lbs. dumbbell in each hand) Hopping on each leg 10 times, making sure that thigh extends on each hop. (10 reps. 3 sets each leg)

3) Heels raise. (Standing--10 lbs. barbell grasped behind neck, balls of feet placed on a 2-inch

high board) Raise heels high then lower again--whole exercise should be carried out at a brisk pace. (10 reps. 3 sets)

4) Shoulder swing. (Standing, feet astride, trunk forward--barbell, 10 lbs. grasped, arms hanging down) Swing arms forward-up until biceps touch ears, then return to starting position. Aim to get barbell high without raising trunk or head. Back and legs should be straight. (5 reps. 3 sets)

5) The punch. (Standing, trunk slightly forward, one foot forward--5 lbs. dumbbell held in each hand at the shoulders) Alternate arm punching sharply forward and pulling back, keeping hands in line with shoulders. Arm should be straightened on each punch. Perform powerfully. (10 reps. 3 sets)

6) Side to side. (Standing, astride, feet to front--5 lbs. dumbbell in each hand) Trunk bending from side to side. As the movement is made to the left the dumbbell in the right hand is drawn up, and under the arm pit, and vice versa. Heels remain in contact with ground at all times and there should be no twisting of the hips. It is not possible to bend very far sideways but what movements are made should be performed throughout a full range. Always look to the front. (10 reps. 3 sets each side)

7) Out and in. (Sitting, hands on ground in line with hips--5 lbs. iron boot on each foot) Raise legs about one foot from the ground, open legs wide and close them again--repeat for one set before lowering legs quietly to ground. It is important to keep the legs straight for the duration of the whole exercise. (5 reps. 3 sets)

8) Triceps stretch. (Standing, feet slightly astride, grasping 10 lbs. barbell above head, hands about 8 inches apart, heels on a 2-inch board) Lower bar on to shoulders allowing elbows to rise as high as possible, then stretch arms again so that the bell is over head. Do not lean either backwards or forwards. Keep heels on board throughout. (5 reps. 3 sets)

Note:- If an athlete "doubles" on field events it is suggested he should perform the weight work applicable to his major event twice as much as that of the minor event. Work at both training schedules should not be done on the same day or in the same session. Occasionally work from each program can be selected--provided each exercises different major muscle groups. Warm-up before work and breathe deeply during it.

WEIGHT TRAINING FOR SCHOOLBOY DISCUS THROWERS

1) Arms side raise. (Standing, feet astride--holding 5 lbs. dumbbell in each hand) Raise arms sideways and lower. Arms should rise only to shoulder height--check this. Stretch tall throughout movement. (12 reps. 3 sets)

2) Trunk twist. (Standing, feet astride--15 lbs. barbell grasped across shoulders) Trunk twisting from side to side. Start gradually by pressing elbow back to turning side. Allow head to follow movement, aim to get full twist effect at waist. Heels should remain on ground. (10 reps. 3 sets)

3) Flying. (Front lying on a narrow table--hands grasping 5 lbs. dumbbell--arms hanging down weights clear of ground, head resting on jaw) Raise arms directly sideways--have this checked--and lower again. Place pad under jaw. (10 reps. 3 sets)

4) Open the door. (Back lying on a low bench, feet flat on ground--grasping 5 lbs. dumbbell in each hand above face) Lower arms sideways, keeping palms of hands upwards, and raising again. Keep arms straight. Fairly slow exercise. (10 reps. 3 sets)

5) Side bends. (Standing astride, feet to front--10 lbs. barbell firmly grasped across shoulders) Trunk bending from side to side. Heels remain on ground. Chest is kept high and back flat. Allow no twisting at the waist. (8 reps. 3 sets each side)

6) Air walking. (Sitting, hands further back than hips, trunk leaning back--5 lbs. iron boot on each foot) Alternate bending and stretching legs in a bicycling action. Bend one leg until heel touches seat and fully stretch other leg making the movement continuous. The whole action should be done as in a circle. (8 reps. 3 sets)

7) Chest fling. (Standing, feet astride--5 lbs. dumbbell in each hand--elbows raised sideways, bar of dumbbell touching chest, palms of hands down throughout) Keeping elbows still fling arms out sideways and return to starting position--continue without pause. Make sure the arms stretch fully. (8 reps. 3 sets)

8) Squat jump. (Standing, feet almost together--firmly grasping 15 lbs. barbell across shoulders) Raise up on balls of feet, then drop to knees full bend position--immediately spring as high as possible fully extending ankles and thighs. As return is made to starting position allow ankles to "give". There should be no pause. Keep bar on neck between sets and keep head up, throughout the performance of the whole exercise. (6 reps. 3 sets)

How They Train

by Fred Wilt

OTIS C. DAVIS, University of Oregon, age 28.

BEST MARKS: 400 m, 44.9 (World and Olympic record); 330 yards, 31.8; 220 yards, 21.0; 200 m, 20.9; 100m, 10.7; 100 yards, 9.6.

BORN: July 12, 1932 at Tuscaloosa, Alabama, 6' 2" (1.88m), 165 lbs. (75 Kg.). Started racing in 1958 at age 26.

PRE-RACE WARMUP: Jog 10-15 min. 5-10 min. calisthenics. 3-4 x 110-220 yards at half-effort. Sprint 150 yards. Walk for recovery after each. Rest 5 min. Get up and jog easily until race. Duration of warmup, 30-45 min.

WINTER TRAINING (January-February 1960)

Monday: (1) 5-15 min. easy jogging. Easy calisthenics. (2) 10 min. of short runs using slow, deliberate strides, bringing knees as high as possible to chest while still maintaining good form. (3) "Fast leg work." Bouncing or pattering the feet off the ground, lifting the feet only a short distance off the ground, and moving the feet as quickly as possible, working the arms in co-ordination with the legs. (4) Either (a) 4-6 starts from blocks at 3/4 full speed, or (b) 4-12 x 100 yards sprints, reaching top speed at 50 yards. Walk for recovery between. (5) Jog 5-10 min.

Tuesday, Thursday, Saturday, and Sunday: (1) Weight training involving a series of lifting which exercises most of the major muscle groups, using half maximum weight capacity for each lift. Then 15 min. easy jogging.

Wednesday: (1) Jog 5-15 min. Easy calisthenics. (2) 4 x 110 yards in 12.5-13 sec. each, reaching full speed at 60 yards and sustaining full striding speed over final 50 yards of each. Walk for recovery after each. As season progresses, increase speed and number to maximum of 10 repetitions. (3) 15 min. fartlek (speed-play) consisting of steady running, sprint 50 yards, walking, 300-500 yards fast striding, 50 yards sprint, and easy jogging.

Friday: (1) Jog 5-15 min. Easy calisthenics. (2) High knee running as in (2) on Monday. (3) Fast leg work as in (3) on Monday. (4) 300-350 yards at 7/8 full effort. Walk for recovery. (5) 200-250 yards at 7/8 full speed. Walk for recovery. (6) 2-4 x 110 yards sprints.

SUMMER TRAINING (May, 1960):

Monday: (1) Jog 5-15 min. Easy calisthenics. (2) 500 yards at 60 sec. 440 yards speed. Walk for recovery. (3) 2-3 x 110 yards sprints. Recovery walk between. (4) 5-15 min. fartlek.

Tuesday: (Same as Tuesday during Winter training).

Wednesday: (1) Jog 5-15 min. Easy calisthenics. (2) 8-12 x 110 yards sprints, or 4-6 x 220 yards at racing speed. Walk for recovery between. (3) 5-10 min. easy jogging.

Thursday and Friday: Jog 15 min. Easy calisthenics. Occasionally a few starts. Very easy.

Saturday: Competition.

Sunday: Rest.

Prior to 1958, Davis was a basketball player. Coached by Bill Bowerman, the 1960 Olympic 400 m champion's competitive season at the University of Oregon started in April and ended in June. He participates in 6-15 meets annually. He begins preparation for track season in October. His workouts are taken in mid-afternoon, and are usually 60-90 min. each. His starting blocks are 19 inches and 34 inches respectively from the starting line. Davis rests two days prior to major competition, and eats his last meal 3-5 hours prior to competition.

His tactics in the 400 m race involve a moderate start, full sprint stride to the 200 m mark, coasting or floating to the middle of the last turn, and accelerating to full effort for the finishing tape.

Teaching Beginners to Pole Vault

by Frank Sharpley

(No event in track and field is more spectacular than pole vaulting, and no technique is more complex and difficult to master. Regardless of the success enjoyed by top class vaulters in the U.S.A., few articles have been published in this country outlining progressive stages in teaching the fundamentals of this event. Frank Sharpley, eminent New Zealand coach, has purposely omitted many refinements and details of vaulting important to the mature and experienced performer in presenting this article for the benefit of the raw beginner.)

TASK. Although a vault is one flowing movement it is best broken up for the beginner into several tasks. These are:

In the run-up, to gather your fastest controlled speed for your particular ability on the pole.

In the plant, to place the pole in the box and jump freely forward and upward (sequence No. 1).

In the hang, to hang loosely behind the pole till you strike it with your chest (sequence No. 2).

In the swing-up, to pull the knees to the hands (sequence No. 3).

In the pull-turn, to shoot your body straight up the pole by fiercely bending your arms while turning your body front-down (sequence Nos. 4 and 5).

In the push, to drive the body still further up by straightening the arms (sequence No. 6).

In the flyaway, to clear the body without fouling.

LEARNING. Vaulting is the most complex of the athletic events, and although the beginner will enjoy learning the technique, a good vaulting movement takes years to perfect. These stages do no more than introduce the boy to the event. Then he will need a textbook. (The best of these is Dr. Richard V. Ganslen's Mechanics of the Pole Vault, 4th edition).

1. Work with a friend at a vaulting box and pit. (The pole for these first two exercises should be strong aluminum or heavy bamboo). Tie a handkerchief to the pole 8 (2.44 m) feet up, and, as your friend stands on the left of the pole as in fig. 1, run in and take off from immediately behind the pole and exactly under the handkerchief, from your left foot, hands close together, right hand above. Your friend swings the pole up and you swing loosely into the air, releasing the pole when it is upright, and dropping into the pit. Repeat this many times, not trying to get high into the air, merely hanging behind the pole till you bump it with your left chest.

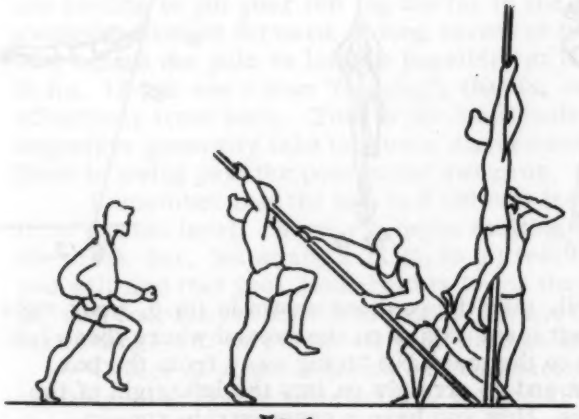


Fig. 1

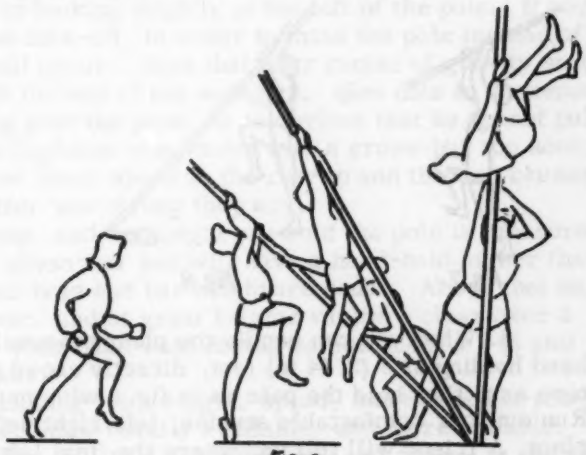


Fig. 2

2. Repeat, and as your left chest touches the pole pull your knees from below and behind you, straight up to your hands. You will need some practice to do this, and may quite likely not be strong enough in your abdominal muscles (fig 2). As you touch knees to hands, turn to the left as you let the pole go, so that you land on your feet rather than on your back.

3. Hold the pole as in fig. 3, forking it with your hands rather than grasping it tightly. Walk then jog around the track, carrying the pole. Keep your shoulders square to the front, press the right elbow out from the body, cock your left wrist down. Do not swing the pole back and forward, let your shoulders swing slightly instead. The front tip of the pole should be at head height and directly in front of you. Repeat many fast and slow runs, holding the pole in this way (fig. 4).

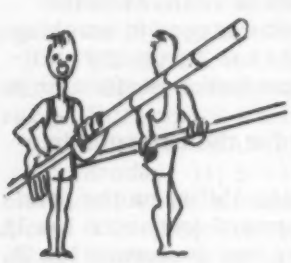


Fig 3

Fig. 4

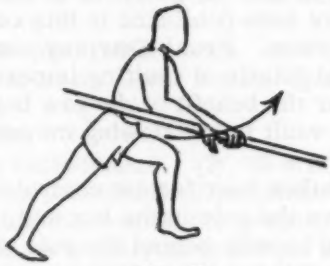


Fig. 5

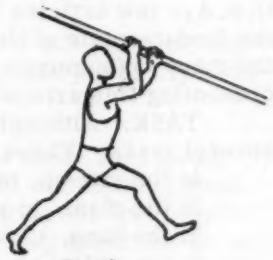


Fig 6

4. Now the plant. First try the movements anywhere on the grass, then into the box. Start by holding the pole with your right hand 8 feet from the bottom in the carry position (fig. 4), then: (a) Take a step with your left foot, at the same time pushing the pole far forward with both hands, and dropping the forward tip of the pole (fig. 5). (b) Your right leg comes forward and your hands swing on forward and upward above your right shoulder. (When working at the box, your pole tip is just landing near the lip of the box.) Your left hand will slide naturally up the pole to meet your right hand (fig. 6). (c) Your left foot goes forward, your hands go higher above your head (bent at about right angles at the elbow, but ready to straighten to cushion the jar); your left foot hits the ground, the pole hits the back of the box, and your right knee swings up (fig. 7). All these planting movements blend into one long swing, like an uppercut taken at a giant well in front of you. This plant must be repeated until it becomes a habit, for most vaulting faults happen on the ground during the run-up and plant. If the pole is just poked into the box you cannot hope to leave the ground at speed and on balance.

Fig. 7

Fig. 8

Fig. 10

Fig. 11

Fig. 12

5. When you can handle the plant reasonably well, take the position shown in fig. 8, your right hand holding at 8 (2.44 m) feet, directly above your left toes. Mark on the ground where these left toes are, then hold the pole as in fig. 4 with your toes to the mark but facing away from the box. Run out four comfortable strides, left-right-left-right and go straight on into the left-right of the plant. A friend will tell you where the final left strikes. Now you have a seven-stride run-up. Turn about and run in to the pit using the same stride plan, counting aloud as in fig. 9.

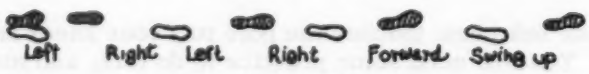


Fig. 9

6. Repeat this many times until you have a fixed seven stride run-up. You will have to move it back a little as you get more confidence and can run in faster. Do not swing up on the pole at first, drop it as it hits the back of the box, and run through the pit. When you can plant with some confidence, getting your final left stride to land near the mark you made earlier, hold the pole and swing up into a loose hang as in the first exercise, head up, back slightly arched (sequence No. 2). In no circumstances use a cross-bar to go over, or your style will fall to pieces.

7. After two or three evenings work on this phase you will be running in smoothly, taking off freely from the same place each time, and hanging loosely so that the pole hits your left chest (if it hits your left hip or leg, you are not hanging). Now try 'hang-knees-up' just as you did in the second exercise. You will not get your knees to your hands for some time, but work at it. Get your knees as high as you can before the pole is straight up, then turn quickly to the left for a safe landing.

8. Increase from four to six running strides in your run-up. Increase the height of your hand-hold as you run in faster, so that you are up to 8 (2.44 m) feet from the ground when your knees hit your hands. If your pole does not reach the vertical and you fall back or into the box, you are holding too high. If you can work at these stages for a full month, so that you run up with your shoulders square to the box, plant smoothly and spring off the ground in one movement, hang and then swing up till your knees touch your hands, you can safely tackle the next stage. Get the high-jump standards and put the cross-bar at a very low height, say 4 (1.22 m) feet. Spend a full evening running in and clearing it by 4 (1.22 m) feet or more, letting the pole go before it touches the cross-bar. You will find this easy to do.

9. Do not raise the cross-bar, no matter what the temptation. Consider your position as your knees reach the pole (fig. 10). (Are you reaching this position, head back, arms almost straight, hips higher than the shoulders?) The next stage is the pull, in which you pull your body vertically upwards by fiercely bending your elbows. A fraction later you kick your right foot up and to the left standard and your left leg, bent, goes scissoring back. (This turn you are already doing instinctively, in order to land at the end of your swing-up.)

At the end of the pull you should be in the same position as that of the man in sequence No. 5.

By this time you will be clearing between 9' (2.74m) and 10' (3.05m), and you will need to start studying a text. Do not copy your local champion, instead learn why each movement is done, by understanding its mechanics. You will then be able to build your full vault by adding the push, and one of the flyaways, which are beyond the scope of this article.

Here are some ideas for the beginner. Look at fig. 11. It shows a take-off, looking from in front. The left foot is behind the pole and the head is looking slightly to the left of the pole. If you are tending to put your left leg too far to the right on take-off, in order to miss the pole instead of swinging straight forward, a long series of faults will occur. Note that your center of gravity should stay behind the pole as long as possible, at least till the end of the swing up. (See dots in sequence.) In fig. 12 you see a man 'flagging', that is, swinging past the pole. It is obvious that he cannot pull effectively from here. This is the main fault of the beginner who vaults with a cross-bar too soon. Beginners generally take too many strides and get too much speed in the run-up and this too causes them to swing past the pole in the swing-up, no matter how strong they are.

Remember that the box is 8 (20 cm) inches deep, and the height you hold the pole is measured from ground level. When you begin vaulting with a cross-bar you will have a hand-hold higher than the cross-bar, but at about 11 (3.35 m) feet the hand-hold and bar height are equal. Above that height you will find that your hand-hold is lower than the bar, and at great heights vaulters clear over 3 (91 cm) feet above their hand holds. Do not change your hand-hold during competition; a 2 (5 cm) inch change will throw out all your timings on the pole.

Choice of a pole depends on many factors, including your weight, speed, and the height you are vaulting. Bamboo is satisfactory, but metal poles are now readily available, and more reliable. Expect the pole to bend. (See front view sequence No. 4.) If it did not do so, and always in the same direction, you would not be able to swing past it.

POLE VAULT TRAINING. The vaulter needs speed, strength and spring, height and some gymnastic ability, and he trains to improve these. The carry-over from gymnastics to vaulting is not good, but some work on ropes and horizontal bar and some mat work is worth while. Weight training is very necessary.

Pole vaulting is ideally an all-year-round event. You are fortunate if you can rig a back-yard box and pit, even with a short run-up. Two inch (5 cm) by 2 inch standards, with nails at 3 (7.5 cm)

inch intervals for pegs and light bamboo cross-bars will work very well. A rake for replacing the bar will save time and temper.

Thirty vaults are as much as you can hope for before tiring. Get in as many as you can; no event demands so much thought and so many repetitions of each of the many movements.

Most vaulting is done with full run-ups, though later you may use short run-ups to polish some points. Tape your present hand-hold on the pole and do not vary it till you know that you can handle another inch.

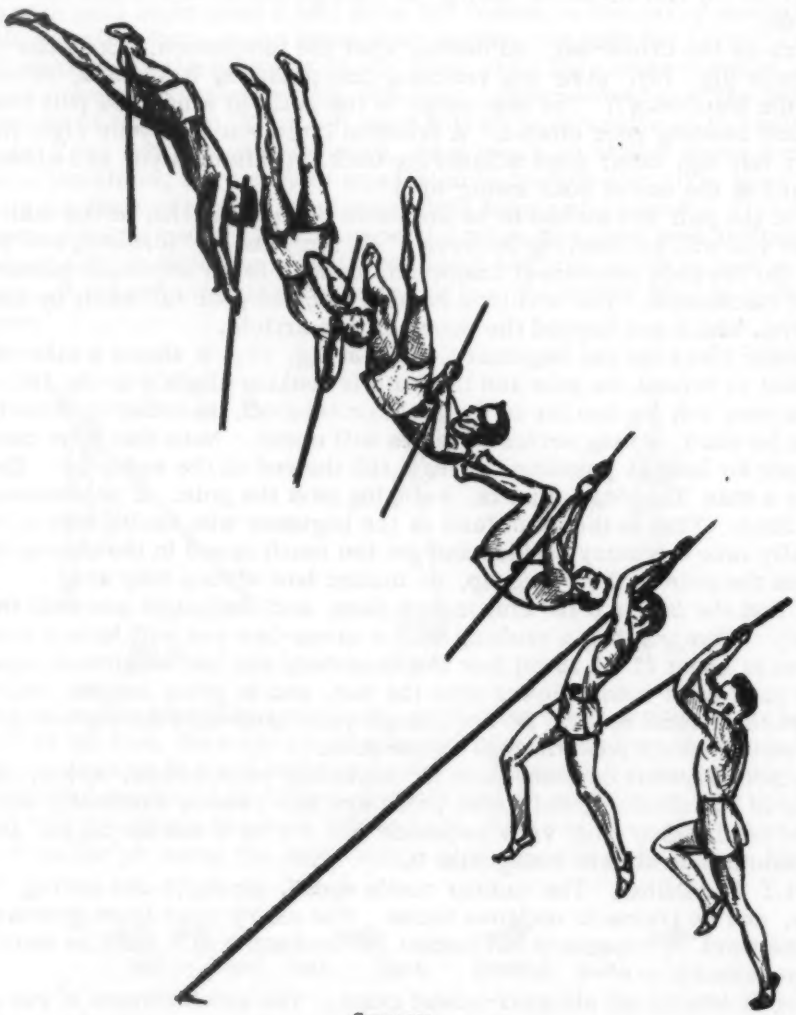
Here is a reasonable practice afternoon for a vaulter after his first season's work.

Warm-up, including two laps of windsprints with the pole.

Measure approach, shake up shavings, run up and swing through twice without cross-bar.

Cross-bar on, at a height you can clear easily. Two or three more jumps at heigher heights till you are 6 inches below your best vault.

Six jumps at that height for a smooth plant, and to check the placing of the left foot at take-off. The left toe below the right thumb, and directly behind the pole. Review your task for the day. Perhaps it is to get the knees higher in the swing-up, or to get a more emphatic pull, or to go on working for a relaxed plant.



Sequence.

Six jumps at this task. Probably the best plan is to think what you want to do, do the vault without 'trying' to get the detail right, and then post-mortem the jump to see if it 'came'. Sometimes, of course, you must consciously do the movement, and even shout out loud to make yourself respond.

Increase the height to 6" (15 cm) above your best. Do not increase your hand-hold. Three vaults at this still uncleared height to get used to it and to learn exactly where you are knocking it off.

Six jumps, with the bar 6" (15 cm) below your best, for your main task. Decide whether to work on the same task tomorrow or to change to another detail.

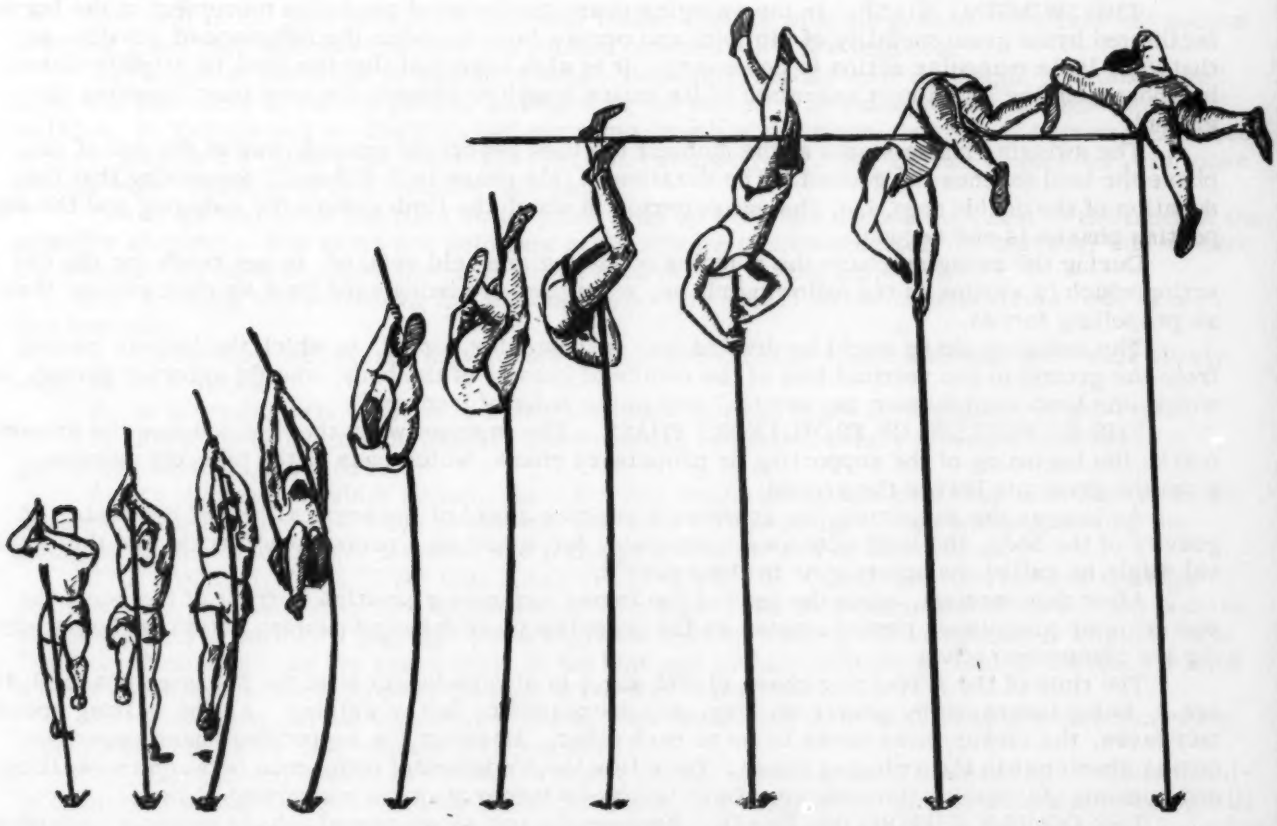
Ten minutes' work on a rope. Swing-ups from a hang position on a still rope, two-handed climbing both upside-down and hanging normally.

Three repetition 440's at as fast a steady speed as you can handle, with a four-minute rest between.

Five training nights would be ideal each week, plus one competition. If you cannot get a competition work through a height trial by yourself, imitating competition conditions. Compete in some other event in club meetings, but do not work on another technical event seriously; you have not time.

Tape your present hand-hold on the pole and do not vary it till you know that you can handle another inch (2.5 cm).

(The above article was reprinted from the booklet entitled "ATHLETICS, A guide book for teachers, coaches and players," by specific permission of its author, Frank Sharpley)



Race Walking

by Ruddi Toomsalu - Estonia

The IAAF rules define race walking as progression by steps so taken that unbroken contact with the ground is maintained. The advancing foot of the walker makes contact with the ground before the rear foot leaves the ground. During the period of each step, in which a foot is on the ground, the leg shall be straightened (i.e. not bent at the knee) at least for one moment.

It has been observed that by ordinary walking, wherein the length of a step is about 32 inches (82 cm.) an increase in the number of steps to 190 in a minute (i.e. more than three steps in a second) inevitably results in running. To avoid running, a different walking style has been introduced, whereby the frequency of the steps has increased even to 220 in a minute (i.e. about 4 steps in a second). At the same time the length of the steps has increased to 47-51 inches (120-130 cm.), and results have been reached that seem to be superhuman for an ordinary walker. One must walk briskly to cover one kilometer within 10 minutes, but the Swede, V. Hardmo, the owner of the 3000 meter world's record of 11:51.8, did it in 3:57.2.

Walking is a process of pushing the body out of balance, while it is supported over one leg and of then bringing the swinging (driving) leg forward in time to prevent the body from falling. This process is repeated with every step by an increasing force until the desired walking speed is achieved. One must remember that forward propulsion is due only to the fact that the extensor muscle forces of the leg apply at the ground in an oblique direction and not in a strictly vertical direction only. (Fig. 1)

For analyzing walking movements it is sufficient to remember that one might divide the action of legs into three phases: 1) the swinging phase, 2) the supporting phase and 3) the double phase.

THE SWINGING PHASE. In the swinging phase the forward pendulum movement of the leg is facilitated bythe great mobility of hip joint and occurs largely under the influence of gravity, so that very little muscular action is necessary. It is also essential that the limb be slightly flexed, by shortening the leg almost one-ninth of its entire length to prevent the toes from touching the ground.

The swinging phase starts at the moment the toes get off the ground, and at the end of this phase the heel touches the ground. The duration of this phase is 0.415 sec. (assuming that the duration of the double step, i.e. the entire period in which the limb covers the swinging and the supporting phases is one second).

During the swinging phase the muscles of the leg are held relaxed, to get ready for the exertion which is waiting in the following phase, when they are being used first as restraining, then as propelling forces.

The swinging phase might be divided into (a) posterior period, in which the limb is moving from the ground to the vertical line of the center of gravity of the body, and (b) anterior period, in which the limb swings from the vertical line to the point of landing.

THE SUPPORTING OR PROPULSORY PHASE. The moment when the heel touches the ground, marks the beginning of the supporting or propulsory phase, which ends at the take-off moment, when the great toe leaves the ground.

As long as the supporting leg assumes a position ahead of the vertical line of the center of gravity of the body, the limb acts as a restraining force (not as a propulsory force), and this interval might be called the anterior or braking period.

After that moment, when the head of the femur assumes a position in front of the heel, the posterior or propulsory period starts, as the propulsory and forward pushing action of the supporting leg comes into effect.

The time of the supporting phase (0.575 sec.) is always longer than the swinging phase (0.415 sec.), being increased by slower walking, and decreased by faster walking. As the walking speed increases, the closer these times come to each other. However the supporting phase never becomes shorter than the swinging phase. Here lies the fundamental difference between the walking and running: In running the swinging phase is always longer than the supporting phase !

THE DOUBLE SUPPORTING PHASE. Between the two above named phases exists a transitional phase or double supporting phase. This is a space of time of 0.081 sec., when both legs are in

contact with the ground. This phase almost disappears when walking is performed with the utmost velocity, namely when the walking borders on the mechanics of running.

RACE WALKING. As soon as we increase our walking speed to the maximum limit, we are confronted with the shortcomings of ordinary walking. We might observe that the basic difference between the slow and the fast walk lies in the height which the two heads of the femur are carried above the ground. The higher they are, the shorter must be a single step, since the leg can remove itself only slightly from the vertical position. When they are in a lower position (fig. 2, P. 2), then the pendulum from forward to backward has a larger amplitude. This coincides with the length of the step. But we know this is associated with bending the knee joints to a greater degree, and that such a low position of hip joints produces a great and tedious burden on the thigh muscles. And now, to reduce that tiresome muscular effort, and at the same time to keep the hip joint in a low position, the head of the femur of the swinging leg is brought downward and forward by a circular movement, with respect to the head of the femur of the supporting leg, (fig. 2 p. 3). The pelvic bones in the hip girdle can do this, with a very slight movement of the spine. Such a downward-forward rotating movement of his hip joint guarantees an extensive movement for the swinging leg. When executing the hip movement correctly, the walker will feel that he is "walking with the hips", and using his legs as extensions.

At the same time the up and down oscillation of the head and trunk disappears, as the supporting leg remains locked from the knee and the head and trunk are always kept at the same height, thus maintaining a constant center of gravity, and the extra burden of the thigh muscles becomes minimized.

Such a walking style is uncomfortable and unfamiliar when training is started, as the hip muscles get tired very soon. But such fatigue disappears after a few training sessions as the unfamiliar movement becomes familiar.

The feet should land with an almost straight inner side as this gives the advantage of correct balance through the toes.

The heel is the first part of the foot that makes contact with the ground. The take-off occurs over the great toe, whereby the toes are pointed outward for a few degrees.

The length of the steps is highly personal, depending mainly upon the height of the body and legs, the looseness of the hip girdle, and the take-off force. For example, the famous Latvian walkers, P. Zeltins and A. Kruklins had the same length of the steps, in spite of a great difference in their heights 5'6" (168 cm.) and 5'11" (180 cm.) respectively. But Zeltins possessed very loose moving hips, which gave him added stride-length.

The arms with clenched fists swing powerfully up and right across the chest to the front of the opposite shoulder. The arms are held bent at the elbows at approximately 90 degrees, and as each fist reaches his highest point, the other drops back in rear of the hip.

For learning and perfecting his walking style, one should stress certain items, one by one. For example:

1. To develop the relaxed movements of legs and shoulders, the walker should walk slowly about 30-40 minutes.
2. In stressing take-offs, it is recommendable that the hands be kept down by the sides.
3. Keep the hands to side position when seeking to perfect rotary movements of the hip girdle and landings, heel first.
4. To improve shoulder action, place a 3-foot length of wooden pole, one inch diameter, on the back, held in place with front of elbows, and walk with prolonged steps while stressing the swinging of shoulders. Keep the head and body upright at the end of each stride.

THE TYPICAL FAULTS OF WALKING TECHNIQUE. 1. Hands are carried in a too high position. Such a position is usually connected with high lifted shoulders, and when walking fast the shoulders tend to perform "jogging" (bounding) movements, making the competitors eligible for a "caution of running", as the knees begin to lift high and contact with the ground is broken. In such a case, encourage a more directly forward drive with the arms.

2. General or partial muscular tension. One should perform stretching and loosening exercises, and long walks with relaxed muscles daily.

3. Exaggerated lateral movement of hips (correct is forward and downward). This is usually connected with a sideward inclination of the trunk. An exaggerated side to side hip swinging will destroy balance, cut down the effective stride, and impose greater stress on the abdominal muscles.

4. Passive, hanging arms by sides. Arms should swing back and forth in the same rhythm

as legs. Passive arms tend to produce lateral sway of the upper body and hamper forward-downward swinging movement of hips.

5. The trunk, due to fatigue or of some other reason, inclines forward some 10-15 degrees. As a result, the hip girdle sinks backward, strides become shorter, and by trying to keep a high walking velocity one might easily start running. In every workout one should control his body stance, by trying to keep his hip girdle in an erect position.

6. Excessive lengthening of steps (a) When in the forward pendulum movement the leg is overextended, or (b) when in the supporting phase the supporting leg is forced to remain on the ground too long. This over-extending or over-stretching action is beyond the walker's capacity, and he exaggerates the turn of his toes outward at the moment of take-off. Thus, the take off becomes weaker, and very often, by trying to keep his walking velocity, springy steps are introduced which lead to running.

7. The swinging leg is brought forward through with a movement which is too high. As a result, the supporting leg very often leaves the ground, before the swinging leg touches the ground. This fault is mostly due to an excessively high hip action in a forward direction. The knee lift, and vigorous drive of the supporting leg, would produce a lifting tendency in the trunk and consequent loss of contact with the ground. This condition demands a retarded supporting leg break, if continuous contact is to be maintained.

8. Walking with bended knees. This is caused by (a) a feeble and defective take-off movement. The supporting leg must not break at the knee prior to the front foot landing, as there is danger of general loss of contact, expecially if any spring is also imparted through the calf at the same time, (b) the swinging leg is grounded before a full extension is reached from the knee, (c) the hip girdle is continuously held in a backward position, (d) just a moment before the landing of the swinging leg, the hip of the supporting leg is falling back from its erect position, and as a result the steps become short and the landing is performed on the sole, but not heel first, or (e) the total contractile force of the anterior part of the leg muscles (the extensors) is too feeble for the extension of the knee joint, or the posterior muscles of the leg (the flexors) are too short and rigid and do not permit full extention which enables the knee joint to reach its natural extended position. The hurdler's exercise, by using both hands for pressure on the forward knee, will help to stretch thigh ligaments and muscles, and concentration on the supporting knee lock when walking will show an improvement.

9. The swinging leg is extended too early in the air before the landing. A delayed landing follows in a jerky manner which may injure the heel. While the landing is delayed, the supporting leg leaves the ground before the swinging leg touches the ground, and running movements are introduced. The swinging leg should be extended exactly at the time of landing, but not sooner or later.

FIGURE 1. In the standing position, the erect body is in a state of equilibrium, as its center of gravity (C) is directly above it's base of support (I). Usually the line of gravity falls about $1\frac{1}{2}$" (4cm) in front of the center of the ankle joint. There is equilibrium between superincumbent weight (P) and the counter pressure from the ground (R), it means that P equals R.

The step forward from a standing position is initiated by an alternation in postural tonus. The tonus of the extensor muscles of the foot and flexors of the leg is diminished, allowing the body to topple forward slowly. At the moment when the center of gravity has passed forward beyond the supporting base of the supporting leg, the balance of the body is lost, and the knee of the swinging leg is flexed and lifted forward (II and III). When the swinging leg touches the ground it displays a restraining action, and in the double supporting phase the superincumbent weight (P) is now locating in the middle of the legs (P_1).

In this position the pressure against the ground is divided between the vertical directions of "a" and "a_1", and of oblique (horizontal) directions of "b" and "b_1" (IV). The faster the speed of walking, the greater is the pressure against the ground, and the friction makes the underlying surface a firm point of application. (Without friction there would be no possibility of forward locomotion.)

The resultant force of "D", composed of the forces "a" and "b" is equal to the propelling force of body (R). At the same time the resultant force "D_1", composed of the forces "a_1" and "b_1", is equal to the restraining force of the body (R_1). As the propelling force "D" is greater than "D_1", then the speed of the walking is dependent upon the strength of the take-offs, and from the angle of the take-off being greater when the application time (duration) of the restraining force "R_1" is as short as possible.

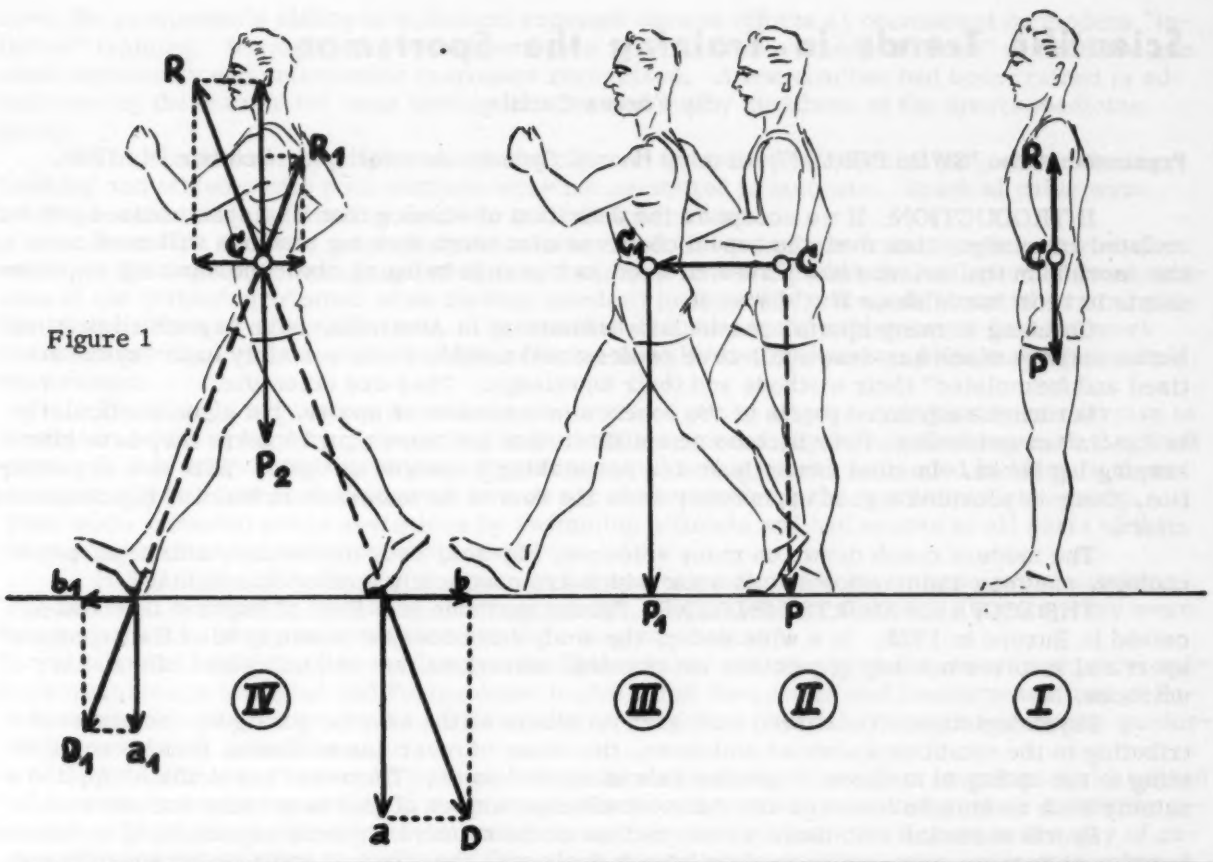


Figure 1

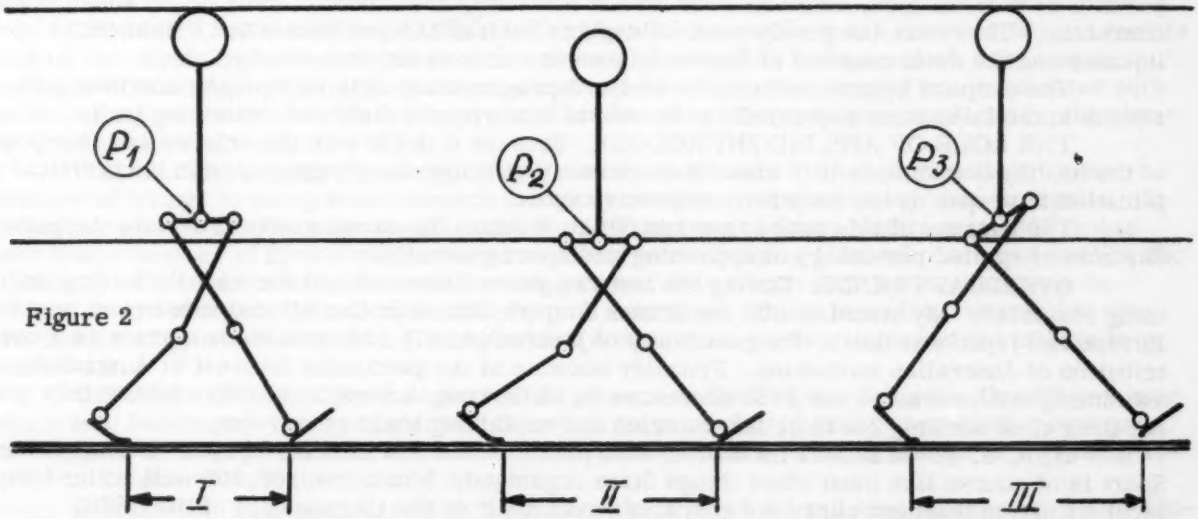


Figure 2

FIGURE 2. 1. Ordinary walking. The hip-girdle "P_1" is in a high position and the step is short. II. The hip-girdle "P_2" and the head are carried in a lower position; the step becomes longer, but the burden (stress) to the thigh muscles is very great. III. In the race walking the hip-girdle "P_3" and the head are carried as high as in ordinary walking, but the step is longer, due to the alternate lowering of the heads of the femurs of the swinging legs, - as low as by walking with lowered hip-girdle "P_2". The great burden of the thigh muscles is in this way eliminated.

(Bibliography on page 24)

Scientific Trends in Training the Sportsman

By Forbes Carlile

Presented at the "SWIM FORUM", History House, Sydney, Australia, on October 24, 1958.

INTRODUCTION: If we accept as the definition of science that it is systematized and formulated knowledge, then even the casual observer of modern training methods will soon come to the conclusion that science has played an important part in bringing about the amazing improvements in sport made since World War II.

Coaching in many sports, particularly swimming in Australia, is no haphazard pastime but an activity which has drawn full-time professional teachers who certainly have "systematized and formulated" their methods and their knowledge. They are scientific.

In turn the advanced pupils of the coaches in a number of sports, but again particularly in Australian swimming, have become scientific in that for more than 10 years they have been keeping log books. In most cases these are painstakingly entered up daily. With this organization, there is provided a good opportunity from the data to formulate theories, linking cause and effect.

The modern coach draws on many sciences, Physics, body mechanics, nutrition, psychology, anatomy and physiology are some which are continually applied in coaching.

THE SCOPE OF SPORTS MEDICINE: Sports medicine is a field of interest first conceived in Europe in 1925. In a wide sense, the study embraces the whole field of the science of sport and involves not only physicians but physical educationalists and exponents of a number of sciences.

Physiologists are concerned with such problems as the effects of fatigue, factors contributing to the condition known as staleness, the cause of muscular stiffness, factors contributing to the ability to maintain muscular relaxation and so on. There are problems of applied anatomy such as muscle leverage and the most efficient angles of pull in various activities.

Sports medicine also deals with questions of the relative physical capacities of males and females at various ages, while another branch deals with the effect of sport on personality and character. There are the purely medical aspects such as the prevention and treatment of sports injuries and the determination of fitness to compete or to train strenuously.

The scope of sports medicine is vast and progress can only be made by continuing research in the laboratory and careful observation in the sports field and swimming pool.

THE ROLE OF APPLIED PHYSIOLOGY: Because it deals with the science and functioning of the healthy human body it is clear that human physiology is of importance in its practical application in preparing the body for competitive sport.

The purpose of this paper is primarily to indicate the extent and to illustrate the present day role of applied physiology in swimming and sport generally.

OVERSEAS TRENDS: During the last two years I have visited the world's leading swimming countries. My attendance at the British Empire Games in Cardiff and subsequent tour in Europe and Japan was due to the generosity of Jantzen (Aust.) Ltd. who made a grant as a contribution of Australian swimming. Probably because of the particular interest in Australian swimming methods since our 1956 successes in Melbourne, scientific workers have freely given me their time showing me their laboratories and explaining their researches.

U. S. S. R: In Russia the nation-wide participation and interest in sport is staggering. Sport is of course like most other things State organized. More than 100,000 well trained physical education teachers carry the gospel of mass sport to the 15 republics of the USSR.

Specialist sport coaches are kept in close liason with research workers in three research Institutes of Physical Education. At the beginning of 1957 the Soviet expanded its work in the aspect of sports medicine concerned with the physiology of the athlete. A staff of 13 at the Central Research Institute in Moscow was increased to 36 and fully equipped laboratories were opened at the Lenin Stadium. Here I saw research teams at work and discussed with scientific workers both mine and their investigations.

I found that the Russians were attacking the problem of the scientific control of the amount of training given to sportsmen. They were investigating what tests may be used to esti-

mate the sportsman's ability to withstand repeated intense efforts as occasioned by modern "interval" training. Blood pressure and heart-rate responses to a standard "dose" of exercise are used extensively and unfavorable responses recognized. A few coaches had been trained in administering these tests but most testing was carried out by members of the sports medicine group.

The electro-cardiograph record was claimed to be useful in determining strain during training and athletes with poor records were not permitted to compete. Brachial pulse wave tracings were used in detecting the over-trained sportsman.

Research workers were studying minute electrical potentials from muscles as an indication of the degree of muscle relaxation. Also, they have found that the well co-ordinated muscles of the trained sportsman when making standard movements gives a different electrical pattern than in the non-trained person. The muscles of a successful athlete were found to work more efficiently with less electrical disturbance than the average person when making standard movements.

The bicycle ergometer was used as a means of giving a measured quantity of exercise to a subject, while a battery of recording instruments recorded physiological changes as they took place. It was noteworthy that at the international swimming events I attended in Moscow there were usually present at each session five or six observers from the sports medicine group. They were accorded every assistance by swimming officials and had access to all parts of the swimming stadium to carry out their work.

HUNGARY: Moscow sets the pattern for sports medicine in the communist countries. The director of physical education in Hungary, Mr. Hepp, told me that in his country they were adopting the Soviet approach but were still "a long way behind".

COMMUNIST CHINA: In Communist China, talks with sporting directors in physical culture institutes at Shanghai and Peking made it clear that the results and recommendations of Soviet research were being adopted. Practically no original scientific research into human performance was being undertaken.

FRANCE: In France the post-war burst of enthusiasm, when Alex Jany was world record holder, for scientific research in swimming seems to have subsided although their scientific director in physical education told me that more activity was planned for France in the way of research.

DENMARK, HOLLAND AND FINLAND: Christiansen in Denmark is world famous for his work on the physiology of muscular exercise although little work has been done on the special problems of training. I found the picture was similar in Holland although I was impressed with the biological research centers in Utrecht and Lieden where the emphasis is placed on the physical performance of man.

Holland, with roughly the same population as Australia and with an appreciably lower standard of living, is doing more towards carrying out this type of research than Australia. In Finland there is a similar situation. At the World Congress of Sport Medicine in 1952 it was clear that a number of first class research workers were applying themselves to research in the physiology of the sportsman. Some interesting research has been done by M. Karvonen on changes in red and white blood cells with physical exercise. There is a clinic attached to the Association of Sports Medicine in Finland where research on the functioning of the athlete is carried out.

CANADA: Canadian physiologists were present at the Empire Games in Cardiff and in an improvised laboratory in a gymnasium a research team conducted fitness tests and measurements, such as a step-test on a number of competitors. This was an indication of a growing interest in Canada of scientific control in sport.

ENGLAND: In England Geoffrey Dyson for track and field and Max Madders and Bert Kinnear for swimming, are prominent in contributing to the scientific research side of their sports. Kinnears and Madders are university lecturers in physical education. Dyson is the editor of the Athletic Association's Coaching Newsletter which regularly carries scientific articles.

JAPAN: Although sport medicine has advanced in Japan since World War II, from my observations I would say there is no close liaison between scientific workers and the swimmers. We were told that during the early 1930's when there was a great revolution in Japanese swimming that there was more applied science. After talking with members of their Swimming Technical Committee, which incidentally counts among its members a number of former Olympic win-

ners, it was clear that in Japan now there is a preoccupation with stroking techniques. Scarcely a question was asked on the subject of training or on aspects of making a peak performance.

UNITED STATES: In June, 1958, I spent some time at Los Angeles, Illinois, Michigan, and at Yale University in New Haven, Conn.

My general impressions were that although the custom is now for physical education graduates to fill coaching positions at the universities, there is practically no applied laboratory science similar to the Soviet Union. The pioneer work of Prof. Thomas Cureton at the University of Illinois is the exception. My wife and I stayed at Cureton's home and I lectured his students in the doctorate school as well as having a number of discussions with the energetic 58 year old professor. The scope of Cureton's work on the physiology of the athlete is set out in his book "Fitness of the Champion Athlete", University of Illinois Press, Illinois 1951.

Cureton's approach has been, so to speak, a cross sectional one. Many outstanding sportsmen including the late John Marshall, Herb McKenley, Bob Richards, Alan Ford etc. were tested extensively at the Illinois laboratories. Tables of standard scores have been drawn up which serve to differentiate the champion from the average untrained man. To a certain extent the question "what makes the SUPERIOR athlete" is being answered by this approach.

Prof. Cureton's interests are divided between testing and improving the athlete, and demonstrating the relationship between regular exercise and fitness and well-being in the middle aged.

Cureton, with his research and academic obligations cannot keep in continuous close contact with the athlete in training.

WORK AT THE "COTTON MEMORIAL LABORATORY": In Sydney we are making an attempt to scientifically control the training of swimmers and other athletes with the aid of laboratory tests. We are employing what may be called the "longitudinal" approach to the investigation and guidance of the sportsman. We are not confining our work to superior athletes but to all who have the enthusiasm to attempt to improve themselves with training. My wife (who incidentally graduated in physical education from the University of Adelaide) and I, are now testing and correlating data from over 100 sportsmen each week. We have named our center the "Professor Frank Cotton" Memorial Laboratory, in honor of the brilliant pioneer work of a man who, in many aspects, led the world in his study of the athlete. The rooms at the pool were made available as a scientific laboratory by the Drummoyne Municipal Council after representations to aldermen by Prof. Cotton.

Briefly, the aim of the testing and measuring at Drummoyne are:

1. To estimate potential.
2. To pin point physical weaknesses and suggest remedies.
3. To provide incentive and demonstrate physiological improvement with training.
4. To provide a scientific aid to the dosing of the training load.

While continually mindful of the research side of our work the primary object of our testing must be to provide useful and immediate information and guidance to our subjects. We must in general restrict testing to what appears the most fruitful approaches, and take the minimum of our subject's time from the extensive training which is necessary nowadays. Another problem is one of finance. Unlike university workers we pay our own expenses. Most of our apparatus we have had to purchase. However, the bicycle ergometer we use is on loan from the physiology department of the University of Sydney and we are indebted to Ted Both of Both Medical Equipment who has made available an electrocardiograph.

Here, briefly, is an account of some of the regular testing items being carried out at Drummoyne.

HEIGHT, WEIGHT, ETC: Height, weight, "index of build" and other bodily measurements are made in order to assess growth from time to time. Comparisons are made with data from outstanding swimmers and the average person.

VITAL CAPACITY: Vital capacity, an indication of lung capacity, is measured before and after a standard exercise. Training improves this value but over-training in accord with the findings of the Soviet Sports Medicine Research Group, decreases the vital capacity.

THE ELECTROCARDIOGRAPH: The electrocardiograph, an instrument which amplifies and records electrical variations during the heart cycle has lately been introduced in our testing. Suspected abnormalities are referred to the physicians. Cureton in the U. S. has made some interesting observations on the results of fatigue and on what characterizes a superior E. C. G. in

the athlete, while the researches of Jim Steele of the school of veterinary science of the University of Sydney on thoroughbred horses, and our preliminary data suggests a very useful field by relating electrocardiograms to the performances of sportsmen.

HEARTOMETER: The Cameron Heartometer records the pulse pressure changes in the brachial artery and reflects the quality and the power of the heart's action. Like Cureton at Illinois we have evidence of marked differences between superior athletes such as Albert Thomas and Alan Lawrence and such swimmers as John and Ilsa Konrads, Brian Wilkinson, Terry Gathercole and the average performer. Further, at Drummoyne we have made serial studies of athletes in training and can show progressive changes including characteristic records indicative of fatigue and over-training. This latter finding is obviously of great importance in athletic guidance.

REPEATED TESTING: The primary reason for repeating a number of tests on sportsmen week by week during the season is to determine whether the organism is successfully carrying the stress of training or whether it is being driven into a state of strain.

BLOOD HEMOGLOBIN LEVELS: One excellent test for detecting strain we have found to be the measurement of the hemoglobin concentration of the blood. Using the "M. R. C." photometer it is possible to make accurate determinations (to within less than about 3%) of the circulating hemoglobin in the blood. We have observed frequently that one of the first signs of strain, followed invariably by poor performances, is a significant lowering of this value. The lowered production of hemoglobin in the red bone marrow of the body may be due to a nutritional deficiency but usually lowering the training load and introducing more rest results in a rise of hemoglobin value and improved performance. Apparently by some physiological mechanism not yet understood, stress affects the red bone marrow.

THE EOSINOPHIL: While at the University of Sydney my study on the changes in the eosinophil cell concentration in the blood confirmed the fact that physical effort causes a lowered concentration but also there was revealed an extremely interesting phenomenon in runners who were training very strenuously. Frequently a flood of eosinophils would appear in the blood and remain for a week or more. The eosinophil count sometimes increased from a normal count of about 100 per cubic millimeter to five or six hundred. At the same time there were distinct signs of strain indicating a lowering of the body's power of adaption to exercise.

PSYCHOLOGICAL ASPECTS: Such observations as these referred to are surely the answer to the often-stated over-simplification "that staleness is mental". Although psychological aspects are important in training, over emphasizing the "mental tiredness" explanation leads one away from making physical measurements and thus recognizing early signs of fatigue which makes possible scientific guidance and prevents a misplaced "pep-talk".

As I have indicated I believe that psychological aspects are most important in attaining peak performance. There is a wide field for scientific investigation here. It was interesting to hear what the Russian attitude was. To quote a Russian professor: "We believe that the word of the coach is of great importance. We are investigating this scientifically".

THE PSYCHOGALVANOMETER: At Drummoyne we have made some preliminary experiments with the psychogalvanometer, an instrument which measures electrical changes in the skin resistance. Changes are marked in a highly strung, nervous individual and may be significantly greater during periods of strain. We hope to gain useful information about the nervous system by taking these measurements under standard conditions.

ERGOMETRY: Ergometry, the measurement of physical work, is carried out at Drummoyne with a bicycle ergometer using the accurate method of Prof. Cotton, with the differential friction band. The most useful measurement I have found, and one independent of bicycling experience, is that of work output in a 30 second burst. The work done in turning the pedals against a heavy resistance load is an excellent measure of explosive power. We have found a very close relationship between a high score on the bicycle ergometer and caliber of sporting performance. On the basis of many thousands of rides by schoolboys we have drawn up tables relating ergometer scores to age. Ergometry has a good predictive value. Young people with a high score for their age will usually perform very well at sport.

HEART RATE AND BLOOD PRESSURE TESTS: Two relatively simple physiological measurements to make are heart rate and blood pressure. In the scientific literature there are many fitness tests involving the heart rate and blood pressure responses to standard exercise. Some of these tests, for instance the step test have their uses in the laboratory. An excellent

Russian test involving the examination of the blood pressure changes after exercise differentiates states of good physical adjustment, overtraining, and a pathological condition of the circulatory system marked by high blood pressure.

Following observations made on members of the Australian swimming squad in Townsville in 1956 we have developed a heart rate response test which relates for the individual the physiological effort and the time of a performance.

This test, which we educate the swimmer to carry out for himself, is useful for both controlling the expenditure of effort in training and in predicting maximum performance. Without the necessity of frequent all-out performances it is possible to assess the day to day form of the individual from a training effort of moderate intensity.

WHO SHOULD TEST? I have given examples of some practical uses of applied physiology in the guidance of sportsmen. Some of the tests could easily be administered by any reasonably intelligent swimming coach but there are several factors making this type of work difficult to carry out. First there is the question of time — both the sportsman's and the coach's. Weekly testing should be streamlined and only the most useful tests made, so that there is not unnecessary cost of training time. The coach cannot usually do very much actual testing himself. His place is at the track or side of the swimming pool. Ideally he should have assistants trained in laboratory work. In order to enable a saving of time and for best co-ordination of activities, I believe that it is almost essential that the laboratory be situated close to where the sportsmen train.

NEED FOR RESEARCH: Before the scientific laboratory control of sport can be carried out on a wide scale I believe that the general problems of sport must be studied in the universities. In Australia there is very little research being made in this field. Research, and providing trained observers, facilities and scientific instruments for testing centers cost money. However, I believe that improving the fitness of sportsmen is no far cry from improving the fitness of the community. The sporting field becomes the testing ground for ideas which are then applied to the average man and woman. Sport has a similar relation to living, much as automobile racing has in helping finally to produce the best family car.

With its high standard of living, good climate and vigorous people, Australia has done well in international sport. However, I believe that in long run, the nations which apply the results of research in human physiology will give their sportsmen advantages which will make International success in sport even harder in the future.

I believe that in showing their willingness to co-operate with the universities and schools of physical education, coaches will speed the day for more applied science and more research in the field of human performance.

New Equipment

A much needed item of equipment is the new "sight bar" for the broad jump. Made of aluminum, it measures each jump accurately and quickly without tape measure. All jumps between 15' (4.57m) and 27' (8.23') are measured within 1/16th of an inch (.15cm). This invention should considerably speed up the time required to complete competition in this event at meets, and serve as a valuable practice aid. It is manufactured by Aluminum Athletic Co., Box 145, Wynnewood, Penna.

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Do Athletes Defy the Law of Gravity?

by Dr. Richard V. Ganslen

Acceleration due to gravity operates in athletic sports just as elsewhere, but there are athletic coaches who sincerely believe that their athletes can or do defy the laws of gravity.

In most sports the body or an object is propelled into the air. If the object is quite heavy and possesses relatively little surface area the effect of wind resistance is negligible.

Under these conditions the athlete must concern himself with only two principle factors which influence his flight or the flight of the object he propells; they are velocity of departure and angle of departure.

It is true that because of improved techniques jumpers go higher and farther than ever before--but not in defiance of the laws of gravity as their coaches imply. Modern high jumping technique permits an athlete to literally roll over a bar with his center of gravity passing below the bar. And since he need not raise his gravity as much as in the old days, better performance results.

The propelling force of a jumper using this style need not be as great as before for average jumps and he can jump higher with less effort, because of this fact. Mike Sweeney jumped over 6'6" with an old-fashioned scissors sit-up style jump more than twenty-five years ago. What might he have jumped using modern techniques?

Obviously it is advantageous for a high jumper to be tall since then he need not raise his center of body weight as far.

Another common fallacy in jumping is that a broad jumper, by hitch-kicking his legs in midair, can increase his elevation or distance travelled. This has come about largely through the fact that Jesse Owens, the World Record holder, happened to use this style jump. Several articles have appeared in popular magazines and newspapers indicating how a broad jumper could increase his velocity and height in mid-flight by kicking the legs.

The writers of these articles are so naive that they do not realize that, according to Newton's Law, action and reaction are equal and opposite, and kicking in midair is equivalent to saying mathematically that something times nothing equals something.

Another fallacy in jumping which physicists and mathematicians are liable to be misled into believing, is that the optimal take-off angle for the jumper is 45 degrees. A careful analysis of this factor by the writer indicates that the 45 degrees is not the optimal projection angle in jumping because of a little recognized fact.

The center of gravity of a man lies at a point 57/100 of his total height from the ground level, 3/100 of an inch lower in women. In jumping, as in the projection of the shot, discus, hammer and other objects, the center of gravity is projected from a point 3-7 feet (.91 to 2.13 m) above the ground level and subsequently falls down to a position at or near ground level. This factor materially influences the parabolic curve path and the angles of projection and landing must be adjusted to consider this factor.

An analysis of this problem revealed that with a constant velocity, the distance of the jumps would vary as follows in accordance with the following angles: with a take-off velocity of 24 ft. (7.31 m) sec. at 55 degrees the distance achieved would be 18.994 feet (5.79 m); at 50 degrees, 20.239 feet (6.166 m); at 45 degrees, 20.940 feet (6.382 m); at 40 degrees, 21.143 feet (6.44 m); at 35 degrees, 20.872 feet (6.362 m), and at 30 degrees, 20.167 feet (6.147 m).

This same phenomena must be reckoned with in the calculation of distances of any objects thrown from above ground level or serious errors in the calculations will result.

Dr. Ganslen is associate professor of physiology and kinesiology at the University of Arkansas. (Reprinted from the October, 1955, issue of SPORTS COLLEGE NEWS)

Concepts of Discus Technique

by Bish McWatt

SIMPLICITY. Some people regard the coaching of discus with awe, as if it were terrifically difficult. This attitude can communicate itself to the athlete so I always try to stress the simplicity of the movement which may lead to bad mechanics but perhaps encourages more athletes.

VELOCITY. As I see it, the discus movement has two velocities, horizontal and vertical. Horizontal velocity is gained in three ways: (a) by speed across the circle, (b) by speed of spin of the whole body, (c) by arm swing.

SPEED ACROSS THE CIRCLE. This is the speed with which the body moves from back to front of the circle. An athlete's aim should be to get from the back to the front as quickly as possible. The best athlete I have seen on loops doing this is Sim Iness (1952 Olympic Champ and First 190 footer (57.91m). Fortune Gordien is also very fast in his progress across. Iness assumes in the middle of his turn a position somewhat like that of a sprinter in his pickup. (Fig. 1).

Fig. 1

Sometimes to emphasize this aspect of the horizontal speed I say to an athlete, "Run across the circle". The movement can be practiced as such and it can help to eliminate the large wide swinging circular movements of the feet, the left one especially, since the athlete is thinking of movement in a straight line as a sprinter does.

SPEED OF SPIN OF THE WHOLE BODY (ANGULAR VELOCITY) With some athletes the emphasis of the velocity is in the spin. Tosi of Italy springs to mind. While the best athletes of this type keep the feet close to the ground and close to the axis of spin, the worst have feet that swing wide and high and thus lose time in covering the extra distance. As a result they land late and the body has already turned to the front instead of keeping back for the final pull. The spin type of movement seems to be more associated with an upright stance and little knee bend in the turn. I have seen athletes who have placed such emphasis on spin that they used less than half of the circle in horizontal distance. In fact they had sacrificed horizontal velocity for angular velocity. I am not going to say that one is more important than the other - the best of both is needed. In coaching, this aspect of velocity can be taught by asking the athlete to think of the waltz turn rhythm - "one-two-three-throw" - rather different from the "run across the circle" of the horizontal movement.

ARM SWING In many ways the final velocity of the arm is merely a continuation of the spin or angular velocity and cannot be separated from it, or for that matter from the horizontal velocity of the whole body as it advances over the left foot in the throwing stance. One can look at arm swing in two ways. Firstly as part of the spin, in which case the athlete spins into the reverse without pause and resembles a spent top as he pivots around his left foot, (as Tosi does), or secondly one can regard it as part of the horizontal velocity across the circle where the release results in almost complete absence of spin or reverse once the arm has followed through. In the one the athlete is thinking "around", in the other he thinks "forward". I am not sure yet which of the two I prefer, and the result is that my throwers get something of both though perhaps inclining towards the second con-

cept.

To summarize, the horizontal velocity comes from the speed of the whole body across the circle, the speed of the whole body in the spin and finally from the arm which adds to these two velocities.

VERTICAL VELOCITY Unless a vertical velocity is added to the horizontal the projectile would come off the hand parallel to the ground and soon fall without great distance being achieved. The actual angle of release of the discus and the angle of the plane of the discus to the horizontal at release will be discussed later. The main sources of vertical velocity are (a) the legs as they thrust up (b) the arm lifts the discus up (c) the trunk as it straightens. It is well to remember that in order to attain vertical velocity one can either use both legs and arms, use the arm without much leg, or use legs without much arm.

To be able to gain some vertical thrust from the legs they must be bent in the throwing stance and in the turn. The degree of bend depends upon several factors; some physical, some related to techniques. Some athletes deliberately keep low in the turn, others are almost upright like a spining pole.

The muscles of the shoulder can play an important part in a vertical lifting of the discus from low behind to up in front. In fact the use of the arm to get height in the discus is the way a beginner attacks the problem, often with disastrous results I have found.

If the body is bent to the rear at the start of the throwing action, any straightening of it must also add some vertical and also some horizontal velocity.

Now how much of each of these contributing vertical velocities should we use? To my mind this depends upon several factors. Richard Ganslen, the author of "Mechanics of the Pole Vault", has discussed these factors in another piece of scientific research, "The Aerodynamic Factors Which Influence Discus Flight". He states that the flatter a discus can be thrown hard, the farther it will go. If a discus faces the air at an angle of greater than 27 degrees it will stall. Now 27 degrees is not high enough a projection angle for a projectile released at 5' (1.52 m) above ground level. This angle is between 35 and 40 degrees according to Ganslen. There is then some 10 to 15 degrees of difference between the ideal angle of tilt of discus and the angle of projection. (Fig. 2) This differ-

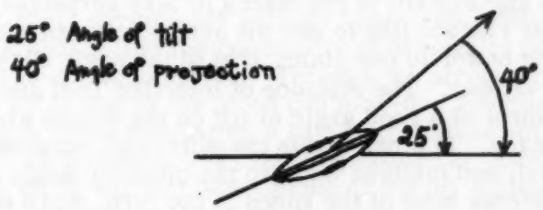

Fig. 2

ence must be made up by some vertical displacement of the discus by altering the angle of tilt of the discus. I believe that the faults of many discus throwers begin here. They open up the face of the discus instead of keeping the thumb down and the result is a continuous state of stall in the discus from the moment it leaves the hand. It flies high then drops steeply as it becomes aerodynamically inefficient.

Where must this vertical lift come from? I believe that the arm should come through on the optimum angle for aerodynamic efficiency (25-27 degrees according to Ganslen's wind tunnel experiments) and the hand and discus also in that angle. In other words the arm should be used mainly for horizontal velocity with only so much vertical velocity as is compatible with this optimum angle. In my mind, to attempt any further vertical displacement or action of the arm or shoulder is to interfere with efficiency at the critical stage of the throw. One can throw a discus into the air on a projection angle of 45 degrees or more and with the discus angle at 20 degrees or less but the loss of power in a horizontal direction just eliminates the advantages of aerodynamic efficiency obtained.

The legs primarily must make up the extra 10-15 degrees of vertical velocity wanted. The back may help but the legs I believe are the real contributors, as the athlete moves across the circle, he should move with bent knees, keeping low, then, once in the throwing stance the arm should come

through at 25-27 degrees with the discus in that angle. The legs should then explode up powerfully to displace the discus vertically so that the optimum angle of projection is reached.

If the athlete does not drive up hard with his legs the angle of projection will be bad but he may get a good tilt of the discus face. A powerful throw of this kind characteristically flies low and fast, often for surprising distances, but lands fast and flat and skims fast off the ground for great distances too, showing that with more altitude the implement would have gone even farther.

Ganslen and I part company on this leg issue. He puts more emphasis on attaining a good projection angle by a vertical displacement of the throwing arm while keeping the thumb down to stop the discus face from opening up. He makes an interesting observation on this:

"There may be, in competitive throwing, no conscious effort in lifting the arm, but still it exists and, if the vertical displacement of the discus, irrespective of method, (arm or leg lift) is too slow, the thrower will be unable to get a good angle of projection. His angle of tilt of the discus face at this time may be perfect." (1)

EFFECT OF WIND. With a head wind the discus thrower can throw farther. There is no such thing as an optimal wind velocity. Quite simply the effect is that of increased velocity of the implement as the wind passes over it. The flatter the discus is thrown as wind velocity increases or as power of throw increases, the farther the discus will go. At low angles of tilt the lift of the discus exceeds the drag to its maximum extent. This tilt is in the vicinity of 25-10 degrees, the angle dropping as greater velocities are produced - 80' (24.38 m) per second or more. Thus my instruction to a thrower with a head wind is, "throw hard and flat". Bad throwers tend to do better relatively than good throwers in such conditions.

With a tail wind both the lift and drag of the discus decline, so a higher angle of projection and a harder throw is necessary though the angle of tilt of the discus will not exceed 27 degrees. The tail wind is usually more in favor of a good thrower though it still does not assist him and optimum throws are harder to produce. A thrower should always aim to make use of as much head wind as he can, and should be prepared to shift around in the circle to get its benefit, providing of course that it does not put his throws out of the sector. This emphasizes too the need for a thrower to be accurate in placing his throws.

CONCLUSIONS. From this discussion on wind it can be seen that "the harder a discus thrower can throw, the lower should be the angle of tilt of the discus to take advantage of the high lift to drag ratio". (2) It is for this reason that I do not like to see the arm interfered with in any way from concentrating almost fully on producing power in one plane, that of the angle tilt of the discus.

To conclude with some observations. The distance of men like Tosi and Consolini I believe comes from their consistent attainment of a good angle of tilt on the discus and the application of power through that angle of release too. In other words the difference between their angles of projection and the angle of tilt was small and inclined more to the optimum angle of tilt. The American throwers however, having often a deeper bend of the knees in the turn, were able to get a bit more height in the angle of projection without interfering too much with the angle of tilt. The latter technique is the more difficult, I believe, and perhaps more inconsistent - especially when we think how long Consolini has been at it.

What I want for my throwers is a low, fast-spinning and fast-travelling turn, an arm and hand and discus coming through at an angle of projection which is the optimum for the greatest speed they can attain and for the head wind they throw into.

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(Reprinted from the Vol. 9, No. 1, December-January, 1961 issue of the New Zealand Amateur Athletic Coaches' Association Monthly Bulletin)

Running and the Chemistry of the Blood

by Dr. Ernst van Aaken, Waldniel, Germany

Blood may be looked upon as a fluid organ, and to its component parts various physiological functions may be attributed among which the mutual relationships between plasma and erythrocytes (red corpuscles) play an important part. One of the most essential functions of blood is that of transport, for it is through the blood that the building, operational and regulatory materials necessary for their structure and function are carried to all the cells of the body. The orderly operation of all life-processes is connected with the constant composition of the blood and indeed, we distinguish between constancy of the pH value, constancy of the osmotic pressure and constancy of the ion-balances.

The blood of a very highly trained person, who is certainly healthier than the average, will in some respects show deviations from the norm, variations which are not to be thought of as pathological, but rather as representing an optimum. Among the many varying values and reactions, we wish to assemble here some of the especially important ones. So, for example, the volume of blood is larger in a trained person, since in the individual organs the volume of blood depends essentially upon the activity of those organs. During sports activity, especially in long-distance running, the metabolism in an organ is livelier than in times of rest. Life does not have a static equilibrium as its basis, but rather a dynamic fluid equilibrium and as soon as accustomed training is decreased or terminated entirely, the organs again become hypertrophied as is the case, for example, with the heart or the kidneys.

Especially interesting are the pH changes in the blood after muscular work. A slight shifting of the blood toward the acid side has the effect on the breath center of increasing breathing and with it increased formation of carbonic acids resulting in a regulartory shifting of the pH toward the alkaline side. The question is, then, whether it is through sprinting or distance running that the acidification releases counter-reactions favorable to the organism in the sense of an increased possibility of the formation of acids - that is, of alkaline reserves - and to which kind of running, sprinting or distance running, greater effectiveness and more favorable effects can be attributed. According to the rule that weak stimuli have no effectiveness, strong stimuli increase, but the strongest stimuli inhibit effectiveness, short sprint work with its anaerobic, suffocation phase often repeated is such an extremely strong stimulus that the possibility of damage is not to be excluded and an improvement in training condition can not be expected. Through the strong formation of lactic acid in sprinting and hard short work, the pH factor of the blood can sink in a few minutes by as much as .2 to .3 units and will only return to its original state after a half hour. Since any shifting of the pH of the organism is to be avoided as much as possible, any resulting change is probably to be interpreted as harmful. In long distance running we do not find this sinking of the pH values since this running is done in a "steady state" and the carbon dioxide (CO^2) thereby rises and at the same time increases the delivery and utilization of oxygen. In acidification of the blood through short distance runs, above all the organic acids increase in the serum and the carbon dioxides decrease. pH changes toward the acid side have as a consequence a movement of the lipoids in the blood from the erythrocytes into the plasma (Lipamie) which makes itself known also by an increase in the cholesterin factors and indicates an unfavorable reaction. In the case of the shifting of the pH to the alkaline side, we have the opposite reaction since the lipoids are taken up into the erythrocytes.[1]

In heavy muscular work, lactic acid increases substantially and can reach an amount up to 10 times that of the rest stage, and will only return to the original condition after about three hours. This increase in lactic acid is to be attributed to the fact that the lactic acid formed during muscular work by the anaerobic disintegration of carbohydrates goes over into the blood. In trained people the increase is smaller and amounts perhaps to 50-60 mg %; but in an untrained person, one finds up to 150 mg %. The increase in lactic acid is especially observable in the lack of oxygen at the end of a 200 meter or 400 meter run while the lactic acid at the end of an equally sharply run 10,000 meter run (without a final sprint) usually does not reach a point more than double that present in a resting state.

With the increase in lactic acid, there is also an increase, though to be sure a lesser one, in pyrotartaric acid.[2] It reaches its high point after hard work a short time later than the lactic acid. In contrast with the formation of lactic acid, the formation of aceton and betaoxybutyric acid is different in accustomed work than in unaccustomed. In an untrained man, in sudden exertion, it comes

to a ketonamie (an accumulation of keton bodies in the blood) which even increases during the recovery period, while in a trained man, this does not occur at all.[3] In muscular work which is accompanied by strong acidification we find an increase in blood-ammonia and increased passing of ammonia in the urine.[4]

The volume of urine material in the serum of a healthy adult amounts to 13-24 mg%. It is the final stage in the disintegration of albumen and is especially increased after very violent muscular exertion and sympathetic stimuli, so especially after sprints up to 800 meters. In trained persons we find an increase in gamma-globulin in the blood albumen which can be shown by simple laboratory methods (Weltmann band-spread and positive cadmium reaction). The globulin fraction is important because of the fact that it contains the largest part of the antigenes of the serum.[5] The height of the blood sugar values in the animal kingdom increases with the liveliness of the animals. Of the birds, the coursers with 150-200 mg% and the good flyers with 200-300 mg% have the highest blood sugar values.[6] It is similar among humans. Sprinters and middle-distance runners up to 800 meters often show values up to 140 mg% without being sugar-sick, but the good distance runners, in a state of rest, almost all show blood sugar values of under 100 mg%. Besides that, the long distance runner reacts more slowly to physical exertion insofar as the increase in blood sugar is concerned.

The base-ions (Kationen) in the blood, such as sodium, potassium, calcium and magnesium comprise in all 154 milli-equivalents per liter of blood serum. In hard, muscular work an increase of the total bases to the extent of 4.5 milli-equivalents appears.[7] According to my own as yet unpublished flame-photometric investigations among top-flight German middle and long distance runners, increases of the total bases of up to 10 milli-equivalents were found. In cases of hyper-ventilation one finds a decrease of 2 milli-equivalents.

The potassium content of human serum normally amounts to about 17-19 mg% = 5 milli-equivalents/Liters. In the case of prolonged exertions such as the marathon run, the potassium excretion in the urine increases from a normal 200 mg% to 800 mg% (according to my own as yet unpublished observations). In badly trained long distance runners and muscular sprinters the potassium in the blood serum climbs as high as 23 mg%.

Calcium in the blood runs normally to about 9-11 mg%. In well-trained distance runners, however, we find mostly lower amounts (7.6-9) probably because of vagotonie.

The magnesium content of human clood amounts to approximately 2.3 mg%. After hard work an increase in the magnesium can be observed.[8]

The blood iodine content, especially the organic, non-alchohol-soluble part, is increased after substantial exertion.[9]

The amount of inorganic phosphorus in the serum can be increased by ultra-violet radiation and by training.[10]

In acid conditons, such as can really occur only after sprinting, inorganic phosphate is released at the expense of organic.[11]

In the blood of untrained persons, the Glutathion, both reduced and total, is lessened by physical exertion. In well-trained persons one observes first an increase, then a decrease.[12]

Higher capacity for performance in endurance is partially dependent on hemoglobin content. With it human blood transports almost 100 times as much oxygen as it releases physically. Hemoglobin values of 100-110% are not unusual among distance men. Hemoglobin acts in the blood like an acid and can combine with alkali and indeed, oxy-hemoglobin is an approximately 70 times stronger acid than hemoglobin. Alkaline reaction of the blood favors the taking up of oxygen and slows up its expenditure. Acid reaction has exactly the opposite effect. In the blood the change in the reaction is contitioned chiefly, if not exclusively, by the concentration of carbonic acid. In high oxygen pressures, the influence of carbonic acid is small and does not hinder the taking in of oxygen in the lungs. In low oxygen pressures, through the increase of carbonic acid, the utilization in the tissues is made easier. If the carbonic acid tension is too low, as for example after forced breathing, oxygen is given off only with difficulty and the tissues are not adequately supplied with oxygen. The same thing happens with increase of the blood alkali. Since under these conditions a large part of the carbonic acid is chemically combined as bicarbonate, the carbonic acid tension in the blood is quite small. This condition is for the most part automatically relieved since as a consequence of the lack of oxygen in the tissues, more strongly acid products, particularly lactic acid, appear and again regulate the blood reaction. In this shifting to and fro of the acid and alkaline reaction of the blood between increase and decrease of lactic acid, one aspect of interval training and repetitive sprint training is

to be seen.

In this short article, a few of the essential points of blood-chemistry have been arbitrarily chosen in order to contribute toward a better understanding of the basic elements in the training of runners.

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(Translated from German by Phil Diamond, Secty.-Treas., National Collegiate Track Coaches Ass.)

Book Review

SCIENCE AND MEDICINE OF EXERCISE AND SPORT

Edited by Warren R. Johnson. Published by Harper and Brothers, 49 East 33rd Street, New York, 16, N.Y. 1960. pp. 740. $12.

This is a technical symposium designed for professional people, to which forty-two leading researchers in physiology, physical education, mechanics, psychology, and medicine have contributed thirty-six chapters. Each chapter begins with a simply stated summary of its contents for the benefit of nonspecialists in the various areas. Bringing together in one volume a statement of our present knowledge of the various aspects of the field of exercise and sports, the book indicates current limitations of our knowledge and suggests the direction of needed research. Much of the material has a direct application to training and technique in athletic efforts. Though not a simple book, it is nevertheless highly readable. The keen and progressive track and field coach will not want to be with out this truly excellent book.

Book Review

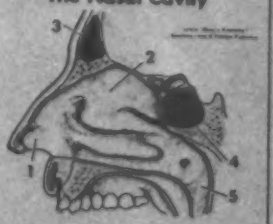
KINESIOLOGY AND APPLIED ANATOMY

By Philip J. Rasch and Roger K. Burke. 1959. Published by Lea and Febiger, 600 Washington Square, Philadelphia 6, Pennsylvania. pp. 456, Illustrated. $7.50.

Although based upon Henry A. Stone's revision of Wilbur Pardon Bowen's Applied Anatomy and Kinesiology, marked advances in basic source fields required such extensive rewriting as to constitute a new work. It provides a thorough and up-to-date factual background for coaches and trainers, for adapted physical education teachers, and for teachers of motor skills. An extensive analysis of normal functioning is provided for corrective, physical, occupational, and recreational therapists. No attempt has been made to oversimplify the subject matter, although the authors have duly recognized the needs of beginning students. Track and field coaches and athletes will find the mechanical analyses of body movements, and chapters on the physiology of muscular contraction, simple mechanical principles of particular utility.

RESPIRATORY SYSTEM

The Nasal Cavity



Sagittal Cross Section

1. Nasal orifice
2. Nasal conchae
3. Frontal sinus
4. Sphenoidal sinus
5. Pharynx with opening of Eustachian tube

Frontal Cross Section

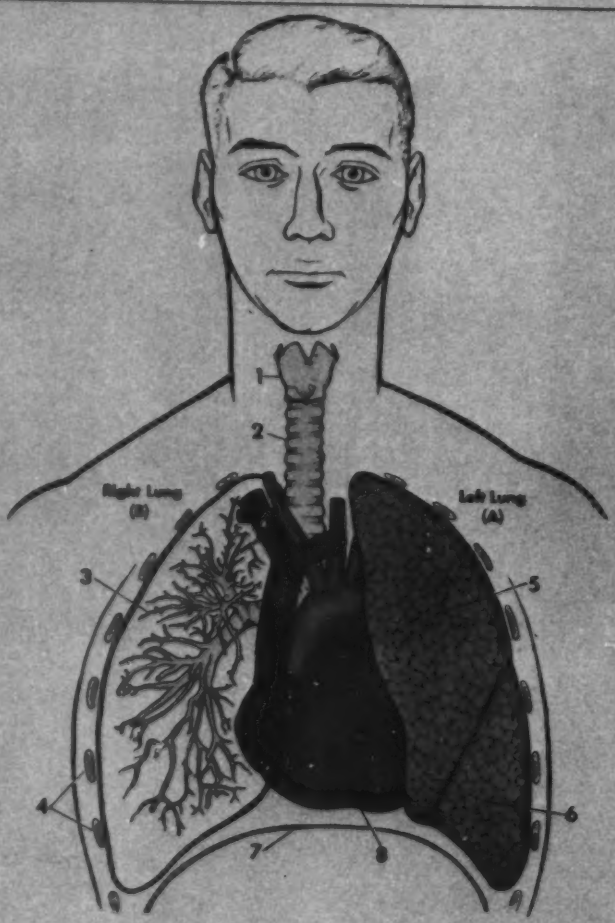
1. Nasal septum
2. Nasal conchae
3. Maxillary
4. Orbits

The Sinuses

The sinuses are air-containing cavities in the skull which, as far as it is known, perform no particular function.

In the above picture the relative positions of some sinuses are shown.

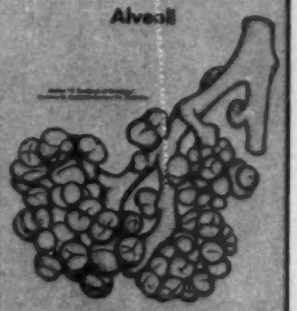
- Frontal Sinuses
- Maxillary Sinuses



The left lung (A) is unopened and shows upper and lower lobes. The right lung (B) is pictured in longitudinal cross section with outlines of bronchial ramifications.

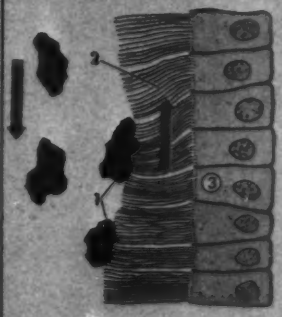
1. Larynx
2. Trachea
3. Bronchial tree
4. Ribs
5. Upper lobe
6. Lower lobe
7. Diaphragm
8. Heart

Alveoli



This is a slightly diagrammatic and greatly enlarged picture of the final ramifications of the bronchi called alveoli. The gas exchange between the blood and the inspired air takes place through the wall of these little chambers (blood vessels are not shown in this picture). If the wall were of all the alveoli in both lungs is rubbed up, we find that this surface approximates the size of a tennis court.

Action of Cilia

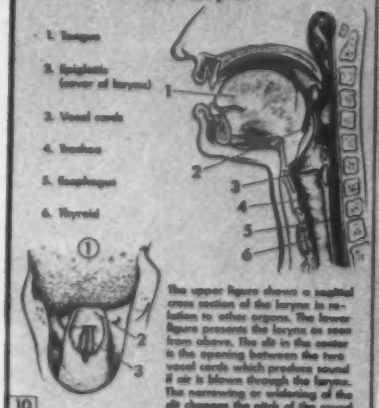


The respiratory vessels, mainly the trachea and bronchi, are lined with ciliary epithelium. The continuous movement of the cilia is of such nature that everything that is deposited on them is slowly transported towards the larynx. In this way inhaled dust particles are eliminated from the respiratory canal after they have settled on the wall of the bronchi or trachea.

1. Dust particles 2. Cilia
3. Ciliary epithelia

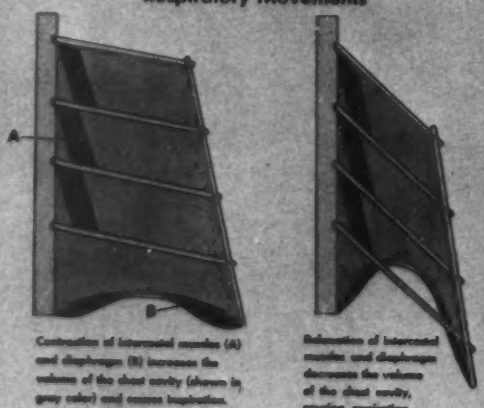
The Larynx

1. Tongue
2. Epiglottis (cover of larynx)
3. Vocal cords
4. Trachea
5. Esophagus
6. Thyroid



The upper figure shows a sagittal cross section of the larynx in relation to other organs. The lower figure presents the larynx as seen from above. The slit in the center is the opening between the two vocal cords which produce sound if air is blown through the larynx. The narrowing or widening of the slit changes the pitch of the sound.

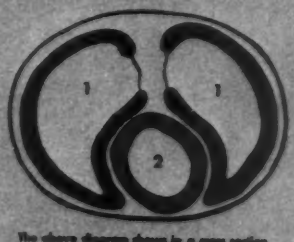
Respiratory Movements



Contraction of intercostal muscles (A) and diaphragm (B) increases the volume of the chest cavity (shown in gray color) and causes inspiration.

Relaxation of intercostal muscles and diaphragm decreases the volume of the chest cavity, causing expiration.

Chest Cavities



The above diagram shows in a cross section how the lungs and the heart are wrapped up in the pleura and the pericard and how the duplication of these membranes is forming the pleural and pericardial cavities.

1. Lungs
   - Pleural cavity
2. Heart
   - Pericardial cavity

10

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Chart reproduced courtesy of A. J. Nystrom Co. (Graphic Health Charts)